Template
Operations & Maintenance Manual

Levee System Name
Levee System Location
MM/DD/YY

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Instructions for Use

An operations and maintenance (O&M) manual is a customized document that describes the activities needed to ensure the reliability and durability of a levee system, along with the methods and resources to be used. It is a best practice for every levee, large or small, to have a comprehensive and current O&M manual. Defining a levee's O&M procedures and documenting them in an O&M manual is best done during the levee's design and construction. If no O&M manual exists for a levee, a good starting point is this O&M manual template, which can be tailored for any levee. Alternatively, all or parts of this template may be added to existing O&M manuals.

This template can be used for most levees. However, not all levees are the same, and additional information may need to be added to address unique topics or conditions. Information from the template can also be deleted if it is not necessary. For example, if a levee has no pump stations, the pump station section should be removed. A levee O&M manual should be considered a 'living' document and updated when changes to the levee or its condition necessitate new procedures for effective O&M.

NATIONAL LEVEE DATABASE

The National Levee Database (NLD) is the national repository for levee data. Each levee has its own public webpage, including a description of the levee. This provides levee owners/operators an opportunity to share current information with the communities behind their levee. Levee owner/ operators can upload their levee's O&M manual to the NLD for safe storage. The NLD can also store information about levee features.

To provide levee information or learn more about the NLD:

- Contact the local U.S. Army Corps of Engineers office.
- Email nld@usace.army.mil.
- Call 1-877-LEVEEUS.
- Use the data change request button on the NLD homepage (https://nld.sec.usace.army.mil).

Understanding the Format

Within the template three text formats are used to denote different types of information:

- *Blue italic text is used for instructions. These paragraphs are labeled as "Instructions" and describe the information that should be included in each section and things to consider as the information is developed. This instructional language may be deleted and replaced with the described information.*
- Black text labeled "Example :Language" is text that may work 'as-is' for many levees. Example language should be edited or deleted, as needed.
- Red text is used to indicate levee information within the example language that must be filled in to tailor the example language for a specific levee.

The O&M manual should be revisited periodically to ensure the criteria and methods are up to date. At a minimum the O&M manual should be updated to reflect physical changes to the levee or changed to O&M processes.

This template includes the following sections:

Section 1 – General Information: *This section provides information about the levee and the area behind the levee to inform O&M actions.*

Section 2 – Administrative Information and Activities*: This section describes the roles and responsibilities of the levee owner/operator(s) and others that have a role in levee O&M. This section also describes the levee owner/operator's processes for accomplishing administrative activities such as staffing the levee, managing a budget, prioritizing and documenting O&M activities, managing encroachments, managing data, and sharing levee information.*

Section 3 – Before a Flood - Managing Systemwide Activities: *This section describes the personnel and processes that will be used to manage and accomplish system wide activities such as inspections, monitoring, O&M, vegetation management and animal control.*

Section 4 – Before a Flood – Implementing O&M for Specific Features*: This section describes each levee feature and provides feature specific criteria, actions, and schedules for O&M activities including inspection, monitoring, operation, and maintenance.*

Section 5 – Before a Flood – Planning and Preparation: *This section describes processes for monitoring the flood source during normal operations, maintaining an inventory of floodfight materials and equipment, and accomplishing floodfight training to ensure readiness to operate the levee during floods and respond to performance concerns if necessary.*

Section 6 – During a Flood – Levee Operations: *This section describes the levee owner/operators processes for operating the levee during a flood, including establishing and staffing an emergency operation center and verifying adequate materials and equipment are readily available. This section also provides feature specific processes for performing pre- and during-flood inspections, installing closures, closing gates, and operating pump stations.*

Section 7 – After a Flood – Recovery: This *section describes how the levee will be returned to pre-flood conditions after a flood event, including preforming post-flood inspections, documenting performance information, and removing / demobilizing materials and equipment.*

<Levee System Name>

OPERATIONS AND MAINTENANCE MANUAL

Contents

List of Tables

Appendices

1 General Information

1.1 Purpose

INSTRUCTIONS: *This section should state the name of the levee this O&M manual applies to and the organization(s) that implement the activities in this manual. All applicable organizations should be listed. Section 2.1 of this document provides an opportunity to further describe roles and responsibilities associated with levee O&M.*

O&M objectives can be listed in this section. It can be helpful to set objectives in order to provide structure and focus to O&M activities.

EXAMPLE LANGUAGE:

This O&M manual describes the activities needed to ensure the reliability and durability of <Levee Name>, along with the methods and resources that will be used. This plan includes administrative and O&M procedures, including O&M procedures to be followed during a flood. This O&M manual is a living document and will be revisited anytime a change occurs to the levee or its O&M processes.

1.2 Levee Location and Access

INSTRUCTIONS: *This section provides the location of the levee and describes how it can be accessed. It should provide:*

- *County(ies) and state(s) in which the levee is located.*
- *Location of the levee relative to nearby towns, major landmarks or infrastructure, and the flood source.*
- *Location of levee access roads and access points. This includes access issues such as:*
  - *Locked gates, including where keys are stored and how they may be obtained.*
  - *Businesses operating adjacent to the levee.*
  - *Animals grazing on the levee.*
  - *Roads that are frequently inundated.*
- *Brief description of the area behind the levee, typically referred to as the leveed area, with information such as size (acres), names of communities, types of land use, number of people living in the leveed area, and the value of protected property.*
- *Map of the levee system to show its location, features, access roads, and access points in the context of the surrounding communities. A levee location and access point map can be included as Appendix A.*

EXAMPLE LANGUAGE:

The <Levee Name> is located on the <east/west/north/south bank of watercourse or body of water> within <City, County, State> < between river miles # and # or near x community>. A location map of the levee is included in Appendix A that includes the levee, levee features, and access points for the levee.

The primary access point(s) for the levee are listed in Table 1-1. <If more detail is needed to explain any of the table entries, provide that information here.> Access points are included on the map in Appendix A.

Table 1-1. Levee Access

Access Point	Security Measure	Lock Details	Contact	Contact info	Access Issues?
Main Street	Locked manual swing gate	Key in Rm 101 of Water Plant	Bill Smith – City Engineer	555-555-5555	Gate provides security for Water Treatment Plant
North of Hwy 71	Locked manual swing gate	Combination 54-89-52	John Jones	444-444-4444	
South of Hwy 71	Cattle guard	NA	John Jones	444-444-4444	Livestock between Hwy 71 and Rt. 52
Rural Route 52	Cattle guard	NA	Sarah Green	333-333-3333	Rt. 52 frequently flooded by rainfall

The levee reduces flood risk to the communities of <community names> from <riverine/hurricane/coastal> flooding from the <flood sources>. Within the <#> acre leveed area is <agricultural/industrial/commercial/residential/recreational development>, including <noteworthy developments>. Critical infrastructure within the leveed area includes <police, fire, hospitals, schools, other>. There are <#> people living and/or working within the leveed area. Critical infrastructure within the leveed area includes <list hospitals, schools, major highways, and other critical infrastructure within the leveed area>.

1.3 Description of Levee

INSTRUCTIONS: *This section should include a summary description of the levee and its features. As-built drawings should either be included in the O&M manual in Appendix B, or a reference should be provided to where they are stored.*

Things that might be included are:

- *Overall length of the levee system.*
- *Length and height of embankment.*
- *Type, height, and length of floodwalls.*
- *Length of channels.*

- *Number of gravity drainage pipes.*
- *Number and type of closure structures.*
- *Number of pump stations.*
- *Total length of seepage berms.*
- *Number of relief wells.*
- *Number and length of drains.*
- *Total length of cutoff walls.*

EXAMPLE LANGUAGE:
The <Levee Name> was originally constructed <dates or timeframes> in response to <event or circumstance that motivated levee construction>. The levee is <#> miles long and consists of <#> miles of earthen embankment, <#> miles of floodwalls, and additional features as listed in Table 1-2.

<Levee Owner/Operator> operates and maintains the levee, including <high level discussion of specific responsibilities during a flood>.

Table 1-2. Levee Features

Levee Features	Length/Number	Additional Information
Embankment length	# miles/feet	Waterside and landside slopes (1V:xH)
T-wall floodwall length	# miles/feet	Height
I-wall floodwall length	# miles/feet	Height Located on embankment?
Gravity pipes (gated)	#	Size/type of gate
Pressure discharge pipes	#	Size
Closures	#	Size/type
Pump stations	#	Number of pumps/capacities
Seepage relief wells	#	Material/diameter
Seepage berms	# miles/feet	Width/drainage layer?
Cutoff walls	# miles/feet	Depth
Toe drains	# miles/feet	Embankment or floodwall?

The levee reduces flood risk to the communities of <community names> from <riverine/hurricane/coastal> flooding from the <flood sources>. Within the <#> acre leveed area is <agricultural/industrial/commercial/residential/recreational development>, including <noteworthy developments>. Critical infrastructure within the leveed area includes <police, fire, hospitals, schools, other>. There are <#> people living and/or working within the leveed area. Critical infrastructure within the leveed area includes <list hospitals, schools, major highways, and other critical infrastructure within the leveed area>.

1.4 Construction History

INSTRUCTIONS: *Describe the original construction and any major rehabilitation or modification efforts. Include start and end dates, the location and areal extent, features included, and a summary of what was accomplished. If there have been multiple construction, modification, and/or rehabilitation efforts, this information may be best presented in a table.*

EXAMPLE TABLE:

Table 1-3. Levee System Construction, Rehabilitation, and Modification

Project Title	Description	State Date	End Date
Project title	Location and extent, features included, and summary of what was accomplished (construction/rehabilitation/modification).	DD MM YY	DD MM YY

2 Administrative Information and Activities

2.1 Roles and Responsibilities

INSTRUCTIONS: *This section should describe the general roles and responsibilities of those that play a part in levee O&M. Some of the organizational roles that may be associated with a levee include:*

- *Those responsible for managing and performing O&M activities.*
- *Those with oversight or regulatory responsibility.*
- *Those who aid in floodfight or emergency response.*
- *Municipalities, businesses, or landowners adjacent to the levee responsible for some aspect of operation, maintenance, inspection, security, or other levee-related tasks.*

2.1.1 < Name of Levee Operating Organization> General Responsibilities

INSTRUCTIONS: *This section should be repeated to describe the responsibilities of each of the levee owner/operator organizations listed in Section 1.1. The following are examples of responsibilities that many levee owner/operators have. Some levee owner/operator may have more or fewer responsibilities, and this list can be tailored to reflect individual situations.*

EXAMPLE LANGUAGE

Inspect the levee system.

Prioritize and perform maintenance and repairs.

Perform all test and flood operations per this O&M manual.

Maintain operating budget for routine O&M activities.

Prioritize maintenance activities to effectively manage risk within available funding.

Plan and budget for non-routine repair, replacement, and rehabilitation.

Train personnel to inspect, operate, and maintain levee features.

Perform flood preparedness and response activities.

Monitor flood source conditions and forecasts.

Inspect the levee system during floods.

Keep local municipalities and jurisdictions aware of conditions on the levee during floods.

Procure and stockpile flood response resources as needed.

Maintain a list of sources for flood response resources (e.g., materials, equipment, labor).

Maintain a list of available heavy equipment, trucks, and boats.

Maintain and update this O&M manual.

Maintain and update the emergency action plan.

2.1.2 <Name of Regulating/Overseeing Organization> General Responsibilities

INSTRUCTIONS: *The following are examples of responsibilities that many regulating/overseeing organizations have. Some organizations may have more or fewer responsibilities, and this list can be tailored to reflect individual situations.*

EXAMPLE LANGUAGE

Inspect the levee system to verify O&M and condition.

Make decisions on capital investments across the regulated portfolio.

Permit construction, modification, and rehabilitation activities.

Coordinate with federal and state emergency management agencies during emergencies.

2.1.3 < Name of Organization Responsible for Emergency Response> General Responsibilities

INSTRUCTIONS: *The following are examples of responsibilities that many emergency response organizations have. Some organizations may have more or fewer responsibilities, and this list can be tailored to reflect individual situations.*

EXAMPLE LANGUAGE

Initiate the Emergency Operations Center.

Coordinate flooding and levee preparedness planning with the community's emergency response organizations, state resources, and levee owner/operators.

Support all floodfighting activities with resources.

Issue public warnings and evacuation notices.

Brief media, public officials, and other interested groups on flooding and levee status.

2.1.4 < Name of Other Organizations involved in Levee O&M> General Responsibilities

x

x

2.2 Staffing

2.2.1 Overview of Staffing

INSTRUCTIONS: *This section should describe the staff available for accomplishing levee activities including:*

- *The number of paid staff members associated with each levee owner/operator.*
- *How levee staff(s) is organized (departments, supervisors, etc.).*
- *If volunteers are used, state how many, how they are recruited and organized, and what services they perform.*

Include a reference to Appendix C with this information or cite other resource that provides a list of staff members, their role/skills, and their contact information.

2.2.2 Staff Training

INSTRUCTIONS: *This section should describe how staff and volunteers are trained to fulfill their responsibilities including:*

- *The person, by position title, responsible for coordinating and accomplishing staff training.*
- *The minimum training for new staff and volunteers.*
- *The frequency of refresher training and how training topics are determined.*

Staff training discussed here should supplement the test operations for closure structures, gates, and pump stations that can be discussed in Section 3.3.2 and in the feature-specific sections of Section 4 of this O&M manual.

2.2.3 Outside Expertise

INSTRUCTIONS: *This section should identify and describe all O&M activities that require outside expertise or services beyond current staff capabilities such as performing interior pipe*

inspection or other activities requiring specialized equipment. It can be useful to include a list of these service providers in Appendix C.

2.3 Access Corridor and Security

INSTRUCTIONS: *Describe the extent of the access corridor required for inspection, maintenance, and operation of the levee or provide a reference map depicting the required access corridor with the as-built drawings in Appendix B.*

2.3.1 Real Estate Interest

INSTRUCTIONS: *Use this section to document the real estate interest held for the levee. Real estate agreements can be included in Appendix B, or a link to this information can be provided.*

- *Describe the easements associated with the levee.*
- *Highlight any locations where adequate real estate rights are not held for a portion of the access corridor needed for adequate O&M. Discuss plans for obtaining additional real estate rights if needed.*

2.3.2 Environmental Permitting and Coordination

INSTRUCTIONS: *Use this section to document any environmental permits, biological opinions, or similar agreements that govern O&M. Permits and agreements can be included in Appendix R.*

2.3.3 Security

INSTRUCTIONS: *Describe how the levee is protected from damage or threat from human activity such as accidental damage, theft, or other criminal acts, and how public safety is maintained from hazardous conditions. This may include access controls such as fencing, gates, locks and alarms, and deterrence measures like signage. Also, describe any additional security measures that are put into place during floods.*

This section should also describe any agreements with local law enforcement or others and the services that are included. Services may include actions to control occupation of the levee by unhoused populations, patrols of the levee before, after, and/or during floods, and additional security and access restrictions during floods.

2.4 Levee Budget

INSTRUCTIONS: *This section describes the budgeting and spending process for the levee. It should include:*

- *The person, by position title, responsible for managing and tracking the budget.*
- *The person, by position title, that has decision making authority for spending.*
- *How the budget is tracked and what software or other tools are used.*

- *Sources of income and associated requirements and schedules.*
- *How and when spending decisions are made and documented, including:*
  - *Meetings or other coordination/approval processes (purpose and timing).*
  - *How the prioritized list of activities discussed in Section 2.5 is considered.*
    - *Reasons to deviate from the prioritization.*
    - *How to document and justify decisions that deviate from the prioritization.*
  - *Other processes that are part of budgeting and spending.*

2.5 Prioritization of Activities

INSTRUCTIONS: *This section describes how levee activities, including inspections, maintenance, repairs, test operations, and levee rehabilitations are prioritized and tracked when available budgets are not sufficient to accomplish all scheduled O&M activities at once (shown in Appendices D thru M), or when larger rehabilitation projects are needed. A complete list of prioritized activities that reflect all levee management needs should be developed and maintained. A prioritized list of required levee activities can help verify limited resources are used effectively. This list can also help identify and communicate budget shortfalls and show how those shortfalls are impacting the levee.*

Activities should be prioritized based on how effectively they manage or reduce levee risk. Not all actions needed to properly manage a levee are levee owner responsibilities. It is a best practice for the prioritized list of actions to include all activities, regardless of the responsible party. For example, some actions like developing evacuation plans and sharing levee information with the public are often the responsibility of emergency management agencies or municipalities; however, it can still be important for the levee owner/operator to understand the status of these actions.

Questions to consider when evaluating a specific action's priority are listed below. As a general rule, each "yes" answer will increase an action's priority.

1. *Is the action a recommendation from a risk assessment? (If yes, priority should reflect the findings of the risk assessment.)*
2. *Is it likely that not accomplishing the action could cause the levee to fail? (If yes, increase priority.)*
3. *Is it likely that the levee will degrade quickly due to this action being deferred? (If yes, increase priority.)*
4. *If this action were not completed, would a levee failure occur and would that failure impact a populated area or significant infrastructure? (If yes, increase priority.)*
5. *Would accomplishing this action decrease the chance of life loss due to a levee breach? (If yes, increase priority.)*
6. *How does the level of effort compare to impact? For example, could a quick, low-cost action have a significant positive impact on the levee? (Actions with higher impacts for lower effort may warrant a higher priority.)*

This section should include:

- *The person, by position title, responsible for making prioritization decisions.*
- *A description of how prioritization decisions are made (i.e., What information is considered? Are there meetings, reviews, other processes used to develop the final prioritized list? Who is involved?)*
- *The process by which the prioritized list of deferred maintenance and test operations, rehabilitations, large component replacements, and other levee risk management actions is maintained, including updates after each inspection, flood, and risk assessment.*
- *A description of how actions to address issues identified during inspections, during and after floods, and through risk assessments are incorporated into the prioritized list of needed actions.*
- *A link or other reference to the prioritized list of needed actions. See Appendix N for an example table that could be used for this purpose.*

2.6 Documenting Activities

INSTRUCTIONS: *This section should describe the process for maintaining a complete history of accomplished actions for each levee feature and component. Document all O&M activities including:*

- *Inspections (formal inspections, interior pipe inspections, and other feature specific inspections).*
- *Routine maintenance and repair activities.*
- *Test operations.*
- *Collection and analysis of monitoring data.*

Documentation should provide information to verify that features and components are being maintained in accordance with best practices and manufacturer warranty requirements and can help communicate levee budget and staffing needs. This record of activities can also help identify chronic issues that may indicate the need for levee rehabilitation.

This section should:

- *Describe how a complete history of accomplished actions is maintained for each levee feature and component.*
- *Provide a link or reference to the record(s) of accomplished activities (Section 2.8).*

2.7 Managing Encroachments and Approved Alterations

INSTRUCTIONS: *An encroachment is any activity on or physical intrusion over, on, through, or under the levee that is not related to the flood risk reduction benefits or other co-benefits the levee is intended to provide. Certain encroachments may be allowed (referred to as approved*

alterations), provided a thorough assessment is completed to verify they do not threaten levee integrity or inhibit access. This section should provide the formal process for reviewing, approving or disapproving, and documenting encroachments and approved alterations on the levee.

2.7.1 Reviewing Encroachments

INSTRUCTIONS: *This section should describe the process used to review and make decisions concerning encroachments including:*

- *The person, by position title, responsible for coordinating the review process for proposed encroachments.*
- *State the person, by position title, responsible for approving/disapproving proposed encroachments.*
- *A description of the encroachment review procedures.*
- *Actions that will be taken when an unapproved encroachment is discovered on the levee.*

2.7.2 Managing Approved Alterations

INSTRUCTIONS: *This section should describe the processes that will ensure approved alterations are constructed and maintained in accordance with requirements established by the levee owner/operator during the encroachment approval process, including:*

- *A description of how construction of approved alterations will be inspected, including the person, by position title, responsible for making sure during-construction inspections occur and are fully documented.*
- *How an inventory of approved alterations will be maintained to inform inspections and other levee management activities.*
- *Many alterations, such as pipes and utilities over, through, or beneath the levee, must be inspected by the alteration owner on a regular basis. Describe how required inspections, maintenance, and repair actions by alteration owners will be verified.*
- *Actions to be taken if alteration owners do not properly inspect and maintain an approved alteration or otherwise fail to meet requirements agreed upon during the approval process.*

2.8 Data Management

INSTRUCTIONS: *This section should describe how levee data is organized and stored. Important levee data that can inform O&M includes:*

- *Design documents including seepage analyses, slope stability analyses, floodwall stability analyses, erosion potential/erosion protection design, etc.*
- *As-built drawings, contract documents.*

- *An inventory of approved alterations.*
- *A record of all accomplished O&M activities including preventative maintenance, repairs and rehabilitations, levee and feature specific inspections, test operations, and collection and analyses of monitoring data.*
- *A record of flood performance and floodfight actions.*

This section should include:

- *The person, by position title, responsible for data management.*
- *How information is stored and backed up (e.g., hard copy, electronically).*
- *Information regarding a folder structure or naming convention, if applicable.*
- *Where information is stored (e.g., physical location, computer drive, the cloud).*
- *A link or other reference to the levee data storage location.*
- *Process for ensuring information in the National Levee Database is current.*
- *Process for ensuring any information that is publicly available is current.*

2.9 Sharing Levee Information

INSTRUCTIONS: *State the person, by position title, responsible for making sure the activities described in this section are accomplished. Describe the methods and frequencies for sharing levee information with local emergency management agencies and/or community leaders responsible for public safety and evacuation planning.*

Also, document any processes for sharing information about the levee and the benefits it provides more broadly. Possible methods include a website, public media posts, public meetings, or newsletters. List any organizations or entities that are partners in delivering levee information and describe their roles. This section will supplement information in Section 6.2 of this O&M manual.

3 Before a Flood – Managing Systemwide Activities

3.1 Managing Inspections

INSTRUCTIONS: *Details about each type of inspection performed on the levee are provided in the sections below. This introductory section should provide overarching information such as:*

- *The person, by position title, responsible for coordinating and making sure inspections are accomplished in accordance with the procedures and schedules included in this O&M manual.*
- *The person, by position title, that will perform inspections.*

- *The person, by position title, to whom inspection results will be reported and that will ensure appropriate actions to address identified issues are determined and prioritized.*

3.1.1 Formal Inspections

INSTRUCTIONS: *Formal inspections are comprehensive inspections performed by a qualified team of levee experts on a repeating, regular schedule to verify O&M, inform levee management activities, and document levee condition. This section should describe the general process for accomplishing formal inspections.*

The formal inspection process description should include the following:

- *How often and when formal inspections will be performed. Formal inspections should be performed at a frequency between one and 10 years based on risk, as follows:*
  - *Levees with a high potential for life loss due to breach should be inspected every one to three years.*
  - *Levees with any potential for life loss due to breach should be inspected every one to five years.*
  - *Levees with no potential for life loss may be inspected at a frequency of up to once every five to 10 years.*
  - *Levees with one or more potential failure modes likely to cause breach prior to overtopping should be inspected on the more frequent end of these ranges.*
  - *Levee conditions that change frequently due to deterioration, animal or human activity, or other forces may indicate the need for more frequent inspections.*
- *How formal inspections will be performed. (The best practice is to walk the entire length of the levee.)*
- *How formal inspections will be documented, including any equipment and/or checklists that will be used. This template includes sections to document feature specific inspection guidance in Section 4. Any inspection checklist should be added as attachments to the O&M manual and can be referenced in Section 4.*

3.1.2 Flood Inspections

INSTRUCTIONS: *Flood inspections are performed prior to, during, or immediately after floods to make sure the levee is ready for a flood. The inspections also document levee performance, identify the need for emergency response activities, and inform maintenance, repair, and rehabilitation needs. This section of the O&M manual provides references to pre-flood and post-flood inspection processes covered elsewhere in this O&M manual and during flood inspections covered in the emergency action plan. (See example language for references to specific sections within the O&M manual.)*

EXAMPLE LANGUAGE:

Pre-flood inspections are covered in Section 6.3.2 of this O&M manual.

Inspection during a flood is covered in the emergency action plan.

Post-flood inspections are covered in Section 7.2 of this O&M manual.

3.1.3 Special Purpose Inspections

INSTRUCTIONS: *Special purpose inspections are performed as needed to capture levee conditions or inform decisions for various purposes. These inspections can typically be discussed as those performed for O&M purposes and those performed to evaluate levee damage due to non-flood events.*

3.1.3.1 Special Purpose Inspections for O&M Purposes

INSTRUCTIONS: *Special purpose inspections for O&M purposes are performed for a variety of reasons. This section should provide information for each type of special purpose inspection commonly performed for the levee. Information should include, as appropriate:*

- *The inspection frequency and schedule for inspections to identify maintenance, repair, and rehabilitation needs between formal inspections. The entire levee can be inspected at one time, or individual features or areas can be inspected. The best practice is for all levee features to be inspected at least once a year.*
- *A list of features that require inspection and/or testing outside of the formal inspection schedule and the activity required. Examples of inspections that may be required outside of the formal inspection schedule include interior gravity drainage pipe inspections, relief well pump testing, and inspections for vegetation management. Tables in Section 4 and in Appendices D-M of this O&M manual template can be used to document the schedules for feature-specific inspections.*
- *Special purpose inspections can also be used to perform test operation of levee features. Examples of test operations that may be required outside of the formal inspection schedule include test gate closures, test closure operations, test pump station operations. Tables in Section 4 and in Appendices D-M of this O&M manual template can be used to document the schedules for feature-specific test operations. Additional information concerning test operations is provided in Section 3.3.2.*
- *A description of how ad-hoc, special purpose inspections that support an activity or meet a requirement will be scheduled and coordinated. These inspections will typically not be scheduled beforehand but will be performed to address needs as they occur. These include:*
  - *Validating levee condition for a risk assessment.*
  - *Fulfilling regulatory requirements.*
  - *Verifying a levee repair, rehabilitation, or approved alteration is constructed in accordance with approved designs.*
- *Describe how all special purpose inspections will be documented, including any equipment and/or checklists that will be used. Checklists should be added as attachments to the O&M manual. Different documentation procedures may be needed for different types of special purpose inspections.*

3.1.3.2 Special Purpose Inspections in Response to Non-Flood Events

INSTRUCTIONS: *Special purpose inspections in response to non-flood events are performed to identify the need for emergency response activities and to identify necessary repairs and rehabilitations. Possible events include earthquakes, wildfires, high winds, and droughts. This section should provide the following information:*

- *A list of events, other than floods, that require inspection of some or all levee features.*
- *The severity of each type of event that triggers an inspection.*
- *The levee features to be included in the inspection and the focus for each inspection.*
- *How inspections will be documented, including any equipment and/or checklists that will be used. Checklists should be added as attachments to the O&M manual.*

In addition to the inspection focus provided in Table 3-1, post-event inspections should follow the inspection guidance provided for each feature in Section 4 of this O&M manual.

EXAMPLE TABLE:

Table 3-1. Event-Driven Inspections with Trigger Conditions

Event	Trigger Criteria	Limits	Focus
Earthquake	Magnitude 4.5 to 5.9 within 50 miles	All features	Inspect for structural damage.
Earthquake	Magnitude 6.0 to 7.9 within 125 miles	All features	Inspect for structural damage.
Earthquake	Magnitude 8.0 or greater within 200 miles	All features	Inspect for structural damage.
Fire	Within the levee access corridor	All features impacted by fire	Inspect for structural damage.
Ice jam	Ice jam impacts levee loading	All features impacted by ice jam	Inspect for debris and erosion.
Exceptionally high tides (King-Tides)	Tide loads the levee	All features impacted by high tide	Inspect for debris and erosion.
Wind	>50 mph	Sta 200 to 10350	Inspect trees immediately riverward of embankment for damage.
Heat	Temperature >112 F	All wiring at pump stations and automated gates	Check wiring and all electronics for heat damage.
Spring Carnival	Annually – immediately following carnival	Sta 200 to 6520	Inspect embankment for debris and sod damage.

3.2 Managing Monitoring

INSTRUCTIONS: *Monitoring is the observation and assessment of levee conditions through collecting and evaluating instrumentation or other data. This section should provide:*

- *The person, by position title, responsible for coordinating and making sure monitoring is accomplished and that monitoring data is evaluated in accordance with the procedures and schedules included in Section 4 of this O&M manual.*
- *The person, by position title, that will perform the monitoring.*
- *The person, by position title, to whom abnormal readings or readings that indicate a possible performance or integrity concern will be reported for verification and action.*
- *The process for verifying abnormal or questionable data.*

Section 4 of this template includes sections to document feature-specific monitoring activities.

3.2.1 Instrumentation

INSTRUCTIONS: *Instrumentation consists of devices installed into or near a levee that provide for measurements used to evaluate the levee's structural behavior and performance parameters. This section should provide a list of instruments associated with the levee.*

EXAMPLE TABLE:

Table 3-2. Instruments Associated with the Levee

Feature	Instrument	Name	location	Purpose
Embankment	Piezometer	P-1	Sta x+xx, offset 50 feet	Evaluate underseepage pressures and confirm proper relief well function.
Floodwall	Settlement gage	Sm-1	Monoliths x/x	Monitor differential movement between monoliths.
Floodwall	Piezometer	P-2	Station x+xx offset 100 feet	Evaluate underseepage pressures.

INSTRUCTIONS: *In addition to the information in Table 3-2, this section should also provide a description of any automation and the associated power source.*

The monitoring sections under each feature in Section 4 can be used to describe monitoring processes and schedules for each feature. The tables in Appendices D-M can be used to document the schedule for collecting and evaluating monitoring data.

3.3 Managing Operation and Maintenance

INSTRUCTIONS: *This section includes processes for managing routine maintenance activities and test operations of levee features. It also provides the process to identify and prioritize activities outside the scope of O&M such as levee rehabilitations and large component replacements. This introductory section should provide:*

- *The person, by position title, responsible for ensuring all O&M actions are scheduled, performed, and documented.*
- *The person, by position title, responsible for consolidating inspection and monitoring findings and determining appropriate repair or rehabilitation actions.*
- *The person responsible for ensuring O&M activities that must be deferred due to a lack of resources and identified rehabilitation needs are incorporated into the prioritized list of activities noted in Section 2.5.*

3.3.1 Managing Maintenance

3.3.1.1 Routine Maintenance Activities

INSTRUCTIONS: *Routine maintenance includes those recurring activities that must be accomplished on a regular schedule to maintain good levee condition. It includes scheduled maintenance (e.g., changing oil, greasing or painting components), small repairs (e.g., repairing small levee slides, normal concrete surface and joint repairs, filling animal burrows), small component replacement (e.g., replacing light bulbs, belts, hoses), and maintaining levee vegetation. These activities are usually fairly consistent and predictable from year to year and can typically be accomplished within the levee's normal operating budget. This section should provide information on how routine maintenance is managed for the levee, including:*

- *The process for scheduling routine maintenance activities. The tables in Appendices D-M can be used to schedule routine maintenance activities for each levee feature. These tables include a format for scheduling recurring maintenance actions that can be planned in advance and for addressing routine repair needs identified during inspections.*
- *The process for consolidating inspection and monitoring findings and determining appropriate repair actions.*

The technical guidance for accomplishing recurring maintenance actions is discussed in the sections covering vegetation and levee features in Section 4 of this manual.

3.3.1.2 Levee Rehabilitations

INSTRUCTIONS: *Levee rehabilitations include those actions required to return a levee system to its intended condition. These activities can be unexpected and often require funding above the levee's normal operating budget. This section should describe how levee rehabilitations—including large repairs and large component replacements (e.g., pumps, stoplogs, gates)—are managed, including:*

- *The process used to identify rehabilitation needs based upon inspection and risk assessment results, and the age and condition of levee components.*
- *How rehabilitation needs are communicated to those responsible for prioritization of levee activities (Section 2.5).*

3.3.2 Managing Test Operations

INSTRUCTIONS: *Operations include all activities or services required to put levee system components into service so that they function as intended, excluding maintenance. Test operations include closing gates, operating closures, and testing pump station pumps on a regular and recurring schedule to ensure all features will operate properly during a flood. This section should provide information on how test operations are managed for the levee, including:*

- *The process for scheduling test operations. The tables in Appendices D-M can be used to schedule test operation activities for levee features.*

- *Frequencies and requirements for test operations are provided under each feature in Section 4.*
- *The process for documenting issues or damages identified during test operations, determining appropriate repair actions, and including these repairs in the prioritized list of action described in Section 2.5.*

3.4 Vegetation Management

INSTRUCTIONS: *This section describes how levee vegetation will be maintained, including:*

- *The area where vegetation will be maintained. This will typically be the property for which the levee owner holds a real estate interest, but it could vary.*
- *The timing and methods for vegetation management.*
- *The standards and objectives of vegetation maintenance (e.g., mow herbaceous vegetation to 6 inches prior to inspection, limb trees up to 8 feet to allow vehicles to pass on the landside access road).*
- *The seed mixes to restore herbaceous cover.*
- *The types and species of vegetation that will be allowed on and adjacent to the levee.*
- *If vegetation zoning is used, the zones should be described, and the vegetation allowed within each zone should be specified.*

3.5 Animal Control

INSTRUCTIONS: *This section should document the animal control program for the levee. The program should identify all animal species common to the levee location that have the potential to damage the levee, either through burrowing (e.g., groundhogs, fire ants, beavers, iguanas) or damaging the levee surface (e.g., wild hogs, armadillos). The animal control program should include:*

- *A comprehensive list of local animal species with the potential to damage the levee.*
- *The characteristics of each species' activity and how it could impact the levee.*
- *Identification of existing or pending protective or environmental legislation that would shape prevention and repair techniques.*
- *Planned actions to prevent future damages/control the presence of animals.*
- *An ongoing process for identifying and repairing damages due to animal activity as they occur.*

4 Before a Flood – Implementing O&M for Specific Features

4.1 Embankment and Associated Features

4.1.1 Description

INSTRUCTIONS: *This section should provide O&M guidance for embankments, including seepage and stability berms, controlled overtopping areas, and non-vegetative erosion protection. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix D.*

4.1.1.1 Levee Embankment

INSTRUCTIONS: *This section should describe the levee embankment in enough detail to inform O&M activities. Details that can be helpful include:*

- *Typical crown width.*
- *Typical waterside and landside slopes.*
- *Embankment material(s), including known variability or zoning.*

4.1.1.2 Seepage and Stability Berms

INSTRUCTIONS: *This section describes the seepage and stability berms associated with the levee. Provide the following information for each berm:*

- *Berm type/purpose: seepage, stability, or both.*
- *Location and extent.*
- *Cross-sectional dimensions or a cross-section drawing.*
- *Material composition.*
- *Location and composition of any berm-related drainage layers (e.g., drains). Inspection and maintenance actions for drains are covered in Section 4.8 of this O&M manual.*

EXAMPLE TABLE FOR MULTIPLE BERMS:

Table 4-1. Seepage and Stability Berms

Location	Purpose	Length Away from Levee	Height Above Levee Toe	Height at Berm Toe	Material Type	Drainage Layer?
station to station	failure mode	# ft	# ft	# ft	sandy silt	yes/no
coordinates to coordinates	failure mode	# ft	# ft	# ft	sandy silt	yes/no

4.1.1.3 Controlled Overtopping Sections

INSTRUCTIONS: *This section should provide a description of any controlled overtopping sections. Controlled overtopping sections are typically sections of levee with a lower crest elevation and erosion protection that allow the levee to overtop without breaching in a location that minimizes consequences. Information should include:*

- *Location and extent of any controlled overtopping section.*
- *Explanation of why this location was chosen and what will be inundated during overtopping.*
- *Cross-sectional dimensions or a cross-section drawing.*

4.1.1.4 Erosion Protection (Non-Vegetative)

INSTRUCTIONS: *This section should include a description of the non-vegetative erosion protection associated with the embankment, including:*

- *Location and extent.*
- *Type of erosion protection.*
- *Typical cross section.*

EXAMPLE TABLE:

Table 4-2. Embankment Erosion Protection (Non-Vegetative)

Location Start	Location End	Type	Extent
station x+xx	station x+xx	riprap	landside slope
station x+xx	station x+xx	slope paving	landside slope
station x+xx	station x+xx	slope paving	crown and landside slope (controlled overtopping section)
station x+xx	station x+xx	grouted riprap	Landside embankment and channel slopes
station x+xx	station x+xx	riprap	channel slope

4.1.2 Inspections

INSTRUCTIONS: *Provide guidance for conducting inspections of the embankment including special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention. Provide any specific guidance associated with berms, controlled overtopping sections, or non-vegetative erosion protections, as needed.*

4.1.3 Monitoring

INSTRUCTIONS: *This section should describe any monitoring activities for the embankment, berms, or controlled overtopping sections such as crest surveys, cross-section surveys, piezometers to monitor seepage pressures, or inclinometers to monitor slope stability. For each monitoring activity, provide the:*

- *Type of instrumentation or activity.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed, or date activity started.*
- *Schedule (or reference the schedule in Appendices D-M) and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.1.4 Maintenance and Repairs

INSTRUCTIONS: *This section should describe recurring maintenance and repair actions for the embankment and berms such as filling animal burrows, debris clean-up, repairing slope sloughs and slides, and repairing erosion and rutting. Provide detailed instructions such as:*

- *A schedule for recurring activities (or reference the schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*

- *Procedures for managing embankment vegetation such as mowing, seeding, planting, controlling weeds, trimming trees and shrubs, removing damaged trees and shrubs, controlled burns, grazing, etc.*
- *Maintenance and repair procedures.*
- *Materials needed such as acceptable soil types with known borrow sources, riprap with required stone size and source, filter material with gradations and source, concrete and asphalt mixes, and appropriate plant species such as seed mixtures or common plant names.*

4.2 Floodwalls

INSTRUCTIONS: *This section should provide O&M guidance for floodwalls and associated non-vegetative erosion protection. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix E.*

4.2.1 Description

4.2.1.1 Floodwalls

INSTRUCTIONS: *This section should describe the floodwall by providing the information in the bulleted list below.*

- *Types of floodwalls included in the levee.*
- *Length and height for each floodwall.*
- *Brief description of wall foundations, including types (e.g., shallow foundation, pile foundation, cantilevered pile walls, anchored pile walls) and locations.*
- *If the toe or heel of the foundation must be buried to a certain depth, provide the required depth.*

EXAMPLE TABLE FOR MULTIPLE FLOODWALLS:

Table 4-3. Floodwalls

Location	Type	Foundation	Length (ft)	Max Height (ft)	Toe Drain?
station to station	wall type	foundation type	# ft	# ft	yes/no

4.2.1.2 Erosion Protection (Non-Vegetative)

INSTRUCTIONS: *This section should include a description of the non-vegetative erosion protection associated with the floodwall, including:*

- *Location and extent.*
- *Type of erosion protection.*
- *Typical cross section.*

EXAMPLE TABLE:

Table 4-4. Embankment Erosion Protection (Non-Vegetative)

Location Start	Location End	Type	Extent
station/other	station/other	protection type	location relative to levee/channel
station/other	station/other	protection type	location relative to levee/channel

4.2.2 Inspections

INSTRUCTIONS: *Provide guidance for conducting inspections on the floodwall(s), including special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

4.2.3 Monitoring

INSTRUCTIONS: *This section should describe any instrumentation or monitoring activities for floodwalls such as surveys, tiltmeters, or settlement markers. For each monitoring activity, provide the:*

- *Type of instrumentation or activity, including any automation or power source.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed, or date activity started.*
- *Schedule (or reference schedule in Appendices D-M) and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.2.4 Maintenance and Repairs

INSTRUCTIONS: *This section should describe recurring maintenance actions for the floodwall such as concrete surface and crack repairs, joint repair, floodwall closure slot or anchorage*

repair, and repair of erosion and animal burrows adjacent to the floodwall. Provide detailed instructions such as:

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *Procedures for managing vegetation adjacent to floodwalls such as mowing, seeding, spraying, planting, and controlling weeds, as well as procedures for removing unwanted debris from the floodwall access corridor and for maintaining the appropriate depth of soil over the floodwall foundation.*
- *Materials needed such as protective coatings, crack sealant, mortar design mixes, joint sealer, acceptable soil material types with known borrow sources, riprap with required stone size and source, filter material with gradations and source, concrete and asphalt mixes, and information about appropriate plant species such as seed mixtures or common plant names.*

4.3 Access Roads

INSTRUCTIONS: *This section should provide O&M guidance for access roads. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix D.*

4.3.1 Description

INSTRUCTIONS: *Describe the location of all access roads maintained by the levee owner/operator. A map of road locations may be useful. (Access roads should be on the map developed in support of Section 1.2 of this O&M manual and that map can be referenced here.) Describe the pavement type for the roads. List any locked gates or other security and how keys can be obtained if needed.*

4.3.2 Inspections

INSTRUCTIONS: *Provide guidance for conducting inspections on access roads, including special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

4.3.3 Maintenance and Repairs

INSTRUCTIONS: *This section should describe maintenance actions for access roads such as regrading and repairing ruts, resurfacing, and removing obstructions. It includes:*

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, materials, and tools required for each activity.*
- *Repair procedures.*

- *Materials needed such as gravel with required gradations, asphalt mixes, concrete mixes, and sealer.*

4.4 Closure Structures

INSTRUCTIONS: *This section should provide O&M guidance for closure structures. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix F.*

Closure structure operation in response to a flood is detailed in Section 6 of this O&M manual. Provide a reference to the operation procedures here.

4.4.1 Description

INSTRUCTIONS: *This section should describe the closure structures in the levee by providing the total number of each type of closure structure and the information in the bullet list below for each individual closure.*

- *Location.*
- *Dimensions.*
- *Closure type, including any required sealing material (e.g., stoplog structure, swing gate, post and panel, sandbag, soil and plastic sheeting, gabions).*
- *Foundation type.*
- *Location of components and operation procedures.*

EXAMPLE TABLE:

Table 4-5. Closure Structures

Closure Name	Type	Levee Station/ Location	Size (ft) (Width x Height)	Component Storage/ Procurement	Test Operation Frequency
closure name	closure type	station / other	# ft x # ft	shed adjacent to closure	all even numbered years
closure name	closure type	station / other	# ft x # ft	na	annual
closure name	closure type	station / other	# ft x # ft	sand – Smith Gravel sandbags – levee shop	years ending in 3, 6, and 9

4.4.2 Inspections and Test Operations

INSTRUCTIONS: *Provide guidance for conducting inspections and test operations of closures, including specific expertise/personnel involved, issues to look for, and areas of concern that warrant extra attention. Inspections should include viewing all components and equipment needed to operate each closure and verifying it is in good condition and stored in a secure location safe from the elements.*

This section should also include the frequency for test operations for all closure structures in the levee (Table 4-5). The required frequencies should be adequate to train and practice closure structure operation, verify operability, and test coordination and installation procedures. Test operations should include practicing a full closure following the processes described in Section 5, including performing all notifications and coordination. Test operations should also include documenting how long the closure operation took, any issues that occurred, and the resources used. (The recurring test operation schedule for each closure can be documented in the O&M tables in Appendices D-M.)

4.4.3 Monitoring

INSTRUCTIONS: *This section should describe any monitoring activities for closure structures such as surveys, tiltmeters, or settlement markers. For each monitoring activity, provide the:*

- *Type of instrumentation or activity, including any automation or power source.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed or date activity started.*
- *Schedule (or reference schedule in Appendices D-M) and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.4.4 Maintenance and Repairs

INSTRUCTIONS: *This section should describe recurring maintenance actions for closure structures such as crack maintenance, seal repair, sill repair, cleaning and painting metal parts, weld repair, lubrication of moving parts, and repair of erosion and animal burrows adjacent to the closure. Provide detailed instructions such as:*

- *A schedule for recurring maintenance activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *Materials needed such as protective coatings, crack sealant, mortar design mixes, joint sealer, and acceptable soil material types with known borrow sources if possible.*

- *How replacement parts are manufactured or sourced, with specific contact information and part information if appropriate.*

4.5 Transitions

INSTRUCTIONS: *This section should provide O&M guidance for transitions, which are locations along the levee where types of features change, such as at closures and floodwalls. An example of schedules that could be developed to manage these O&M activities is provided in the feature-specific inspection and maintenance schedules for embankments (Appendix D), floodwalls (Appendix E), and closure structures (Appendix F).*

4.5.1 Description

INSTRUCTIONS: *Transitions between two types of levee system features create vulnerable locations that warrant special consideration during inspection and maintenance. This section should list all of the transitions within the system including:*

- *Location.*
- *Features involved.*
- *Erosion protection or other elements specific to the transition area.*

EXAMPLE TABLE:

Table 4-6. Transitions

Transition Location	Feature 1	Feature 2	Erosion Protection
station x+xx	high ground	embankment	riprap
station x+xx	embankment	floodwall	slope pavement
station x+xx	floodwall	embankment	slope pavement
station x+xx	embankment	high ground	sod

Note: Procedures and guidance for inspection and maintenance of erosion protection associated with transitions should be included in Sections 4.1.1.4 and 4.2.1.2.

4.5.2 Inspections

INSTRUCTIONS: *Provide guidance for conducting inspections on transitions, including special expertise/ personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

4.5.3 Monitoring

INSTRUCTIONS: *Typically, monitoring at a transition will be associated with one of the levee features involved in the transition. Monitoring for levee features at transitions should be covered within the section for each individual levee feature.*

4.5.4 Maintenance and Repairs

INSTRUCTIONS: *This section should describe recurring maintenance actions for transitions. In some cases, many of the maintenance actions for transitions will be the same as for the features involved in the transition. This section should provide any additional maintenance actions specific to transition areas. Provide detailed instructions such as:*

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, materials, and tools required for each activity.*
- *Repair procedures.*

4.6 Seepage Control Features – Cutoff Walls

INSTRUCTIONS: *This section should provide O&M guidance for cutoff walls. Since cutoff walls are completely below grade, inspection and maintenance activities for these features is minimal. Monitoring activities should be documented under the larger feature the cutoff wall is associated with, typically an embankment or floodwall.*

4.6.1 Description

INSTRUCTIONS: *Describe cutoff walls by providing the following:*

- *Location and extent.*
- *Depth of wall.*
- *Type/material it consists of.*

Since cutoff walls are below grade, knowing the exact location is critical.

4.6.2 Inspections

INSTRUCTIONS: *Since cutoff walls are completely below grade, inspection procedures should consist of viewing the ground surface over the wall for a linear depression or other signs that the cutoff wall may be degrading. Describe how these inspections will be accomplished, including special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

4.6.3 Maintenance and Repairs

INSTRUCTIONS: *Cutoff walls are below grade and typically do not require maintenance or repair. Should inspection or monitoring indicate a possible issue with a cutoff wall, actions outside the scope of O&M are typically required. This section should describe observations or issues that indicate further evaluation of the cutoff wall is needed.*

4.7 Seepage Control Features – Relief Wells

INSTRUCTIONS: *This section should provide O&M guidance for relief wells. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix G.*

4.7.1 Description

INSTRUCTIONS: *Describe relief wells associated with the levee by providing the as-built information listed below for each well.*

- *Relief well number/ID.*
- *Location.*
- *Installation date.*
- *Well diameter.*
- *Depth.*
- *Riser length.*
- *Screen length.*
- *Location and length of any unscreened sections.*
- *Discharge elevation.*
- *Design-specific yield (flow rate).*
- *Description of any drainage systems, including pipes and gates/valves.*

Table 4-7 may be helpful. If the levee system has numerous relief wells, it may be preferable to move this table to an appendix and reference the appendix here. If relief well data is managed on separate software, that software can be referenced here instead of including a table.

EXAMPLE TABLE:

Table 4-7. Relief Wells

Relief Well ID	Location Start	Date Installed	Dia (in)	Discharge Elevation (ft)	Depth (ft)	Riser Lgth (ft)	Screen Lgth (ft)	Blank Lgth (ft)	Design Specific Yield (GPM)	Pump Test Frequency
RW-1	station x+xx	6/12/1992	10	332	85	12	63	10		YE in 1,6*
RW-2	station x+xx	6/17/1992	10	333.2	80	11	54	15		YE in 1,6
RW-3	station x+xx	6/21/1992	10	332.7	87	15	57	15		YE in 1,6
RW-4	station x+xx	6/26/1992	10	332.4	78	16	52	10		YE in 1,6

RW-5	station x+xx	9/12/2001	10	334.6	84	17	62	5	YE in 1,6
RW-6	station x+xx	9/21/2001	10	334.4	76	14	52	10	YE in 1,6

* Years ending in 1 and 6.

4.7.2 Inspections and Pump Testing

INSTRUCTIONS: *Provide guidance for conducting inspections of relief wells, including methodology, special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

Typically, visual inspections of the exposed portions of relief wells and the ground surface around relief wells will be performed in conjunction with the inspection of the feature with which the relief wells are associated. Discuss specific items to focus on during the surface inspections.

Provide frequency (Table 4-7) and methodology for completing pump testing and internal relief well inspections, as well as how results are evaluated and used to inform maintenance or replacement decisions. Define the pump test results that will trigger well rehabilitation or replacement.

Provide a frequency for internal inspection of pipes associated with relief well drainage systems. Discuss specific items to focus on during the internal pipe inspection.

The relief well and relief well testing schedule and drainage system internal inspection schedule can be documented here or in the O&M tables in Appendices D-M.

A separate database for relief wells is a good way to record all relevant data that is needed for maintenance, testing and rehabilitation. Typical data to capture during maintenance and testing includes current depth, specific yield, and efficiency. If a database is used, reference it here.

4.7.3 Monitoring

INSTRUCTIONS: *This section should describe any monitoring activities for relief wells such as piezometers and flow measurement devices. For each monitoring activity, provide the:*

- *Type of instrumentation or activity, including any automation or power source.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed, or date activity started.*
- *Schedule (or reference schedule in Appendices D-M) and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.7.4 Maintenance and Repairs

INSTRUCTIONS: *This section should discuss maintenance and repair actions for relief wells, including replacing damaged parts, removing debris and sedimentation from around well outlets and from within drainage pipes, and repairing erosion and animal burrows adjacent to the wells. Provide detailed instructions such as:*

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Repair procedures.*
- *How replacement parts are manufactured or sourced with specific contact information and part information if appropriate.*

4.8 Seepage Control Features – Drains

4.8.1 Description

INSTRUCTIONS: *This section should provide O&M guidance for drains. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix H.*

Describe drains by providing the information below. Cross sections may be useful.

- *The feature with which it is associated.*
- *Location and extent.*
- *Materials the drain is composed of, including any zoning or layering.*
- *Description of any pipes, outlets, gates/valves, or other components.*

EXAMPLE TABLE:

Table 4-8. Drains

Location Start	Location End	Associated Feature	Type	Pipe Dia (in)	Interior Inspection Frequency
station x+xx	station x+xx	floodwall	toe drain	6	YE in 4, 9*
station x+xx	station x+xx	embankment - berm	blanket drain	na	na

* Years ending in 4 and 9.

4.8.2 Inspections

INSTRUCTIONS: *Provide guidance for conducting inspections of drains, including methodology, special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

Provide a frequency for internal inspections for pipes associated with drains (Table 4-8). Discuss specific items to focus on during the internal inspection.

Typically, inspections of exposed portions of drains and the ground surface above drains will be performed in conjunction with the inspection of the feature with which the drains are associated. Discuss specific items to focus on during the surface inspections.

The internal inspection schedule can be documented here or in the O&M tables in the Appendices D-M.

4.8.3 Monitoring

INSTRUCTIONS: *This section should describe any monitoring activities for drains such as piezometers and flow measurement devices. For each monitoring activity, provide the:*

- *Type of instrumentation or activity, including any automation or power source.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed, or date activity started.*
- *Schedule (or reference schedule in Appendices D-M) and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.8.4 Maintenance and Repairs

INSTRUCTIONS: *This section should discuss maintenance and repair actions for drains, including replacing damaged components, removing sediment and debris from pipes and gates/valves, and repairing erosion and animal burrows adjacent to drains.*

Provide any additional specific considerations, such as materials and tools needed for maintenance and repairs, and detailed instructions including:

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *How replacement parts are manufactured or sourced with specific contact information and part information if appropriate. Provide information on filter material, including gradation and source.*

4.9 Channels and Floodways

INSTRUCTIONS: *Note that channels and floodways can have a separate O&M manual. This section of the levee O&M manual should cover channel and floodway concerns that could impact the integrity of the levee.*

4.9.1 Description

INSTRUCTIONS: *This section should provide O&M guidance for channels and floodways related to the levee. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix I.*

Describe designed channels and floodways that are a part of the levee project by providing the following information:

- *Location.*
- *Cross section.*
- *Type (e.g., earthen, concrete lined, riprap lines).*

4.9.2 Inspections

INSTRUCTIONS: *Provide guidance for conducting inspections of channels and floodways as they relate to the levee, including methodology, special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

Typically, inspections of channels and floodways in relation to the levee will be performed in conjunction with levee inspections. If there will be deviations from the general levee inspection schedule, document those here.

4.9.3 Monitoring

INSTRUCTIONS: *This section should describe any monitoring activities for channels and floodways such as water level gages, slope inclinometers, or sediment/erosion surveys. For each monitoring activity, provide the:*

- *Type of instrumentation or activity, including any automation or power source.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed, or date activity started.*
- *Schedule (or reference schedule in Appendices D-M) and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.9.4 Maintenance and Repairs

INSTRUCTIONS: *This section should describe recurring maintenance actions for channels and floodways such as vegetation management, removing sediment and debris, repairing slope sloughs and slides, replacing riprap, repairing damage to slope paving, and repairing erosion. Provide detailed instructions such as:*

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*

- *Repair procedures.*
- *Materials needed such as acceptable soil types with known borrow sources.*

4.10 Interior Drainage System – Gravity Drainage Pipes

INSTRUCTIONS: *This section should provide O&M guidance for gravity drainage pipes, gates, headwalls and gatewells. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix J.*

Gate operation in response to a flood are detailed in Section 5 of this O&M manual. Provide a reference to the gate operation procedures in this section.

4.10.1 Description

INSTRUCTIONS: *Describe gravity drainage pipes associated with the levee's interior drainage system by providing the following for each pipe:*

- *Location.*
- *Date of construction.*
- *Length.*
- *Diameter.*
- *Inlet and outlet invert elevations.*
- *Material.*
- *Type of gate(s).*
- *Description of any gate automation.*
- *Description of any associated headwall or a gatewell.*

Table 4-9 may be helpful.

EXAMPLE TABLE:

Table 4-9. Gravity Drainage Pipe Descriptions

Name	Location	Date of Constr.	Dia (in)	Inlet Invert El. (ft)	Outlet Invert El. (ft)	Length (ft)	Pipe Material	Gate Type
Pump Station #1	station x+xx	1973	60	93.5	96	120	concrete box	sluice
Big Ditch Gate	station x+xx	1973	60	94	97	135	RCP	sluice
Little Ditch	station x+xx	1990	24	94.6	97	115	CMP	flap

Pump Station #2	station x+xx	1990	30	94.7	97	115	CMP	flap

* Years ending in 3 and 8.

4.10.2 Inspections and Test Operations

4.10.2.1 Gravity Drainage Pipe

INSTRUCTIONS: *Provide specific considerations for conducting inspections of gravity drainage pipes and pipe joints, including methodology, special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

Provide a frequency for interior pipe inspections for each pipe (Table 4-10) and include any special required equipment. Discuss the process for interior pipe inspection and specific items to focus on.

Typically, inspection of the visible portions of the pipe and the surrounding ground surface will be performed in conjunction with the inspection of the feature with which the gravity drainage pipe is associated. Discuss specific items to focus on during the exterior inspections.

The schedule for interior pipe inspections can be provided here or in the O&M tables in Appendices D-M.

EXAMPLE TABLE:

Table 4-10. Gravity Drainage Pipe Inspections

Name	Location	Date of Constr.	Dia (in)	Length (ft)	Pipe Material	Inspection Method	Pipe Interior Inspection Frequency
Pump Station #1	station x+xx	1973	60	120	concrete box	walk through	YE in 3,8(1)
Big Ditch Gate	station x+xx	1973	60	135	RCP	walk through	YE in 3,8(1)
Little Ditch	station x+xx	1990	24	115	CMP	CCTV(2)	YE in 3,8(1)
Pump Station #2	station x+xx	1990	30	115	CMP	CCTV(2)	YE in 3,8(1)

(1) Years ending in 3 and 8.
(2) Closed circuit television.

4.10.2.2 Headwalls and Gatewells

INSTRUCTIONS: *Provide specific considerations for conducting inspections of headwalls and gatewells, including methodology, special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

Typically, headwall and gatewell inspections will be performed in conjunction with the inspection of the feature with which the gravity drainage pipe is associated. Discuss specific items to focus on during headwall and gatewell inspections.

4.10.2.3 Gates

INSTRUCTIONS: *This section should describe specific considerations for conducting inspections on gates, including specific expertise/personnel involved, issues to look for, and particular areas of concern that warrant extra attention.*

This section should also include the frequency for test operations for all gates in the levee (Table 4-11). It is a best practice to test each gate during each levee inspection.

The schedule for all gate test operations can be provided here or in the O&M tables in Appendices D-M.

EXAMPLE TABLE:

Table 4-11. Gravity Drainage Pipe Gates – Test Operations

Name	Location	Gate Type	Gate Automated?	Gate Test -Operation Frequency
Pump Station #1	station x+xx	sluice	yes	annual
Big Ditch Gate	station x+xx	sluice	no	annual
Little Ditch	station x+xx	flap	na	annual
Pump Station #2	station x+xx	flap	na	annual

4.10.3 Monitoring

INSTRUCTIONS: *This section should describe any monitoring activities for gravity drainage pipes and appurtenances such as surveys and settlement plates. For each monitoring activity, provide the:*

- *Type of instrumentation or activity, including any automation or power source.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed, or date activity started.*
- *Schedule (or reference schedule in Appendices D-M) and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.10.4 Maintenance and Repairs

4.10.4.1 Gravity Drainage Pipe

INSTRUCTIONS: *This section should describe recurring maintenance actions for gravity drainage pipes and pipe joints such as sediment and debris removal, coating, sealing, repairing small areas of corrosion, removing roots from pipe joints, and pipe joint repair. Provide detailed instructions such as:*

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *Materials needed such as joint filler, crack and concrete sealer, pipe coatings, grout mixes, replacement pipe sections, or patches.*

4.10.4.2 Headwalls and Gatewells

INSTRUCTIONS: *This section should describe recurring maintenance actions for headwalls and gatewells such as concrete surface and crack repairs, concrete joint repair, loss of riprap, and repair of erosion and animal burrows adjacent to the headwall or gatewell. Provide detailed instructions such as:*

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *Materials needed such as protective coatings, crack sealant, mortar design mixes, joint filler, riprap, and acceptable soil material types with known borrow sources if possible.*

4.10.4.3 Gates

INSTRUCTIONS: *This section should describe recurring maintenance actions for gates such as seal repair, cleaning and painting metal parts, weld repair, and lubricating mechanical parts. Provide detailed instructions such as:*

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *Materials needed such as lubricants and paint.*
- *How replacement parts and materials are sourced with specific contact information and part information if appropriate.*

4.11 Interior Drainage System – Ditches and Ponding Areas

INSTRUCTIONS: *This section should provide O&M guidance for ditches and ponding areas. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix K.*

4.11.1 Description

INSTRUCTIONS: *Describe the interior drainage ditches and ponding areas that are a part of the levee project by providing:*

- *Location.*
- *Dimensions.*
- *Type (e.g., earthen, concrete lined, riprap lined).*

4.11.2 Inspections

INSTRUCTIONS: *Provide specific considerations for conducting inspections of interior drainage ditches and ponding areas, including methodology, special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

Typically, inspections of interior drainage ditches and ponding areas will be performed in conjunction with levee inspections. If there will be deviations from the general levee inspection schedule, document those here.

4.11.3 Monitoring

INSTRUCTIONS: *This section should describe any monitoring activities for interior drainage ditches and ponding areas such as water level gages or sediment/erosion surveys. For each monitoring activity, provide the:*

- *Type of instrumentation or activity, including any automation or power source.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed, or date activity started.*
- *Schedule (or reference schedule in Appendices D-M) and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.11.4 Maintenance and Repairs

INSTRUCTIONS: *This section should describe recurring maintenance actions for interior drainage ditches and ponding areas such as vegetation management, removing sediment and debris, repairing slope sloughs and slides, and repairing erosion. Provide detailed instructions such as:*

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *Materials needed such as acceptable soil types with known borrow sources.*

4.12 Pump Stations

4.12.1 Description

INSTRUCTIONS: *This section provides O&M guidance for pump stations. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix L.*

Provide the number of pump stations associated with the levee. For each pump station provide the information below.

- *Location.*
- *Organization responsible for operating the pump station during floods if different from the levee owner/operator or if there is more than one levee owner/operator organization.*
- *The number, type, purpose, and capacity of pumps.*
- *Description of any automation.*
- *Source of power.*
- *Source of back-up power.*

EXAMPLE TABLE:

Table 4-12. Pump Stations

Name	Levee Station	# of Pumps	Total Pump Capacity (GPM)	Power Supply	Back-up Power	Test Operation Frequency
Pump Station #1	station x+xx	3	100,050	electric	diesel generator	March, Sept
Pump Station #2	station x+xx	1	6,700	diesel	na	March

Note: Pump stations should have a separate technical manual provided by manufacturers at installation to guide operations. This section can be used to supplement the technical manuals with a consolidated set of pump station specific data and additional operational procedures that have been established by those that operate and maintain the pump station(s) based on experience.

4.12.2 Pump Station Building and Components

4.12.2.1 Inspections

INSTRUCTIONS: *Provide specific considerations for conducting inspections of pump station structures, including methodology, special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

Typically, inspections of pump station buildings will be performed in conjunction with levee inspections. If there will be deviations from the general levee inspection schedule, document those here or in the O&M tables in Appendices D-M.

4.12.2.2 Monitoring

INSTRUCTIONS: *This section should describe any monitoring activities for pump station structures such as settlement surveys, piezometers, and water level gages. For each monitoring activity, provide the:*

- *Type of instrumentation or activity, including any automation or power source.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed, or date activity started.*
- *Schedule (or reference schedule in Appendices D-M) and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.12.2.3 Maintenance and Repairs

INSTRUCTIONS: *This section should describe recurring maintenance actions for pump station structures such as cleaning and painting metal and other surfaces, roof repairs, sealing walls, joints, and cracks, and cleaning storage and work areas. Provide detailed instructions such as:*

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *Materials needed such as paint, sealant, and joint filler material.*
- *How replacement parts and materials are sourced with specific contact information and part information if appropriate.*

4.12.3 Pumps, Motors, and Power Systems

4.12.3.1 Inspection and Test Operations

INSTRUCTIONS: *Inspections of pumps, motors, and power systems (primary and back-up power) should be accomplished while intermittently operating the pump. If pumps are operated*

automatically, test operations should verify proper function of the automation systems. Provide specific considerations for conducting inspections, including methodology, special expertise/personnel that need to be involved, issues to look for, and particular areas of concern that warrant extra attention.

Inspection of pump motors and power systems typically occur during the levee inspections, but should also be performed after floods, large windstorms, extreme heat events, and power disruptions. Section 3.1 should include event driven inspections of pump stations to address these conditions.

4.12.3.2 Monitoring

INSTRUCTIONS: *This section should describe any monitoring activities for pumps such as instrumentation of pump flow rates, surveys, and levels. For each monitoring activity, provide the:*

- *Type of instrumentation or activity, including any automation or power source.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed, or date activity started.*
- *Schedule (or reference schedule in Appendices D-M) and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.12.3.3 Maintenance and Repairs

INSTRUCTIONS: *This section should describe recurring maintenance actions for pumps such as adding/replacing oil, lubricating parts, adjusting and replacing belts and seals, and aligning gears and drives. Provide detailed instructions such as:*

- *A schedule for recurring activities (or reference schedule in Appendices D-M).*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *Materials needed such as oil and lubricant.*
- *How replacement parts and materials are sourced with specific contact information and part information if appropriate.*

4.12.4 Intake and Outlet Works

4.12.4.1 Description

INSTRUCTIONS: *Describe the gates, valves, intake and discharge pipes, and trash racks associated with each station.*

4.12.4.2 Inspection and Test Operations

INSTRUCTIONS: *Provide specific considerations for conducting inspections of pump station intake and outlet works, including methodology, special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention.*

Identify the frequencies for test operation of gates, valves, mechanical trash racks, etc.

Identify the frequency for interior intake and discharge pipe inspections. Provide areas of concern or focus for the interior pipe inspections.

Typically, inspections of the visible portions of pipes and the surrounding ground surface will be performed in conjunction with the regularly scheduled levee inspection. Discuss specific items to focus on during the exterior inspections.

4.12.4.3 Monitoring

INSTRUCTIONS: *This section should describe any monitoring activities for inlet and outlet works such as surveys, and water level gages. For each monitoring activity, provide the:*

- *Type of instrumentation or activity, including any automation or power source.*
- *Purpose of the instrument or monitoring activity.*
- *Instrument location or area within which the activity will occur.*
- *Date the instrument was installed, or date activity started.*
- *Schedule and process for obtaining and evaluating data.*
- *Monitoring results that will trigger actions and what those actions should be.*

4.12.4.4 Maintenance and Repairs

INSTRUCTIONS: *This section should describe recurring maintenance actions for pump station inlet and outlet works such as cleaning and painting metal parts and removing silt and debris. Provide detailed instructions such as:*

- *A schedule for recurring activities (can be included here as a table or combined with schedules for recurring maintenance on other features as an appendix).*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *Materials needed such as oil and lubricant.*
- *How replacement parts and materials are sourced with specific contact information and part information if appropriate.*

4.13 Instrumentation

4.13.1 Description

INSTRUCTIONS: *This section should provide O&M guidance for instrumentation. An example of a schedule that could be developed to manage these O&M activities is provided in Appendix M.*

4.13.2 Inspections

INSTRUCTIONS: *This section should provide guidance for conducting inspections of instrumentation including special expertise/personnel that need to be involved, issues to look for, and areas of concern that warrant extra attention. It is likely that the list of personnel and concerns will be different for different types of instrumentation.*

4.13.3 Maintenance and Repairs

INSTRUCTIONS: *This section should describe recurring maintenance actions for levee instrumentation such as recalibration and replacing missing or damaged parts. Provide detailed instructions such as:*

- *A schedule for recurring activities.*
- *Equipment, staff, and tools required for each activity.*
- *Repair procedures.*
- *How replacement parts and materials are sourced with specific contact information and part information if appropriate.*

5 Before a Flood – Planning and Preparation

5.1 Flood Source Monitoring During Normal Operations

INSTRUCTIONS: *Provide the person, by position title, responsible for monitoring flood source data during normal operations and the frequency of monitoring. This frequency can be developed by considering the availability of flood source data, how quickly flood source conditions can change, and how much lead time is needed to prepare the levee for an impending flood loading. Think about the time required to perform pre-flood inspections, perform any identified minor repairs or maintenance, operate levee features, and perform pre-flood notifications.*

EXAMPLE LANGUAGE:

The <position title of responsible personnel> will monitor the data and forecasts issued for <flood source> stages, basin-wide rainfall that could impact stages, and local heavy rainfall that

could affect interior drainage. During routine operations, data will be monitored <daily/weekly/other>. When conditions are predicted that will result in a flood loading on the levee, <position title of personnel to be notified> will be notified to start flood operations.

The <Gage Name> gage is located < River Mile or other location information>. Typically, river forecasts at this gage are provided <when> and take into account past precipitation and precipitation amounts expected approximately <#> hours into the future from forecast issuance time.

<Provide link to gage data or other data source>

If the flood source is slow rising (i.e., changes in river elevation are predicted days in advance), use this paragraph:

The <flood source> generally rises slowly. A slow rate of rise allows time to communicate pertinent information and operate levee features. Typically, the <Levee Owner/Operator Organization Name> will have <# hours/days> to act once a loading on the levee is predicted.

If the flood source is fast rising (i.e., changes in river elevation are predicted hours in advance), use this paragraph:

The <flood source> generally rises quickly. The flashy nature of <flood source> means there is limited time to operate levee features and communicate pertinent information. Typically, the <Levee Owner/Operator Organization Name> will have <# hours> to act once a loading on the levee is predicted.

5.2 Materials and Equipment

INSTRUCTIONS: *This section should describe the ongoing process used to ensure there are adequate materials, personnel, tools, and equipment available to respond to a flood.*

To effectively develop this section, think through all of the activities performed during a flood, including operating features, performing inspections, and implementing floodfight actions and then make a list of all the materials and equipment required to effectively operate and maintain the levee through a typical flood. Evaluate the list of required resources and decide what should be kept on hand and what can be obtained immediately prior to or during a flood. It may be helpful to provide a reference in this section to Section 6.3.3 of this manual so users of the manual can quickly find all information associated with flood resources management.

This section should provide the following information:

- *The person, by position title, responsible for managing flood response materials and equipment, including resources needed for levee feature operations and for floodfight.*
- *A list of materials and equipment that must be kept on-hand to respond to floods. See Appendix O.*
- *Where materials and equipment are stored.*
- *The schedule and process for regularly inspecting stored materials and equipment.*
- *The process for replacing materials as needed due to deterioration or use.*

- *The schedule and process for verifying the contact information for suppliers and confirming the continued availability of resources on a regular basis See Appendix P.*

EXAMPLE LANGUAGE:

The <Levee Owner/Operator Organization Name> shall evaluate flood operation and maintenance needs of the levee on a <frequency> basis to maintain a list of minimum required materials and equipment required for successful flood response. The <Levee Owner/Operator Organization Name> will procure and stockpile floodfight supplies in accordance with this list. A list of nominal supplies that should be on-hand at all times to respond to a flood is maintained in Appendix N.

<Position title of responsible personnel> is responsible for ensuring the minimum required supplies list is accurate, current, and includes all materials and equipment needed to operate and maintain the levee during a flood. They are also responsible for procuring and ensuring the good condition of materials in accordance with the supplies list.

On-hand supplies are stored <describe storage location>. At a minimum, supplies will be inspected to ensure adequate supplies are on-hand and are in good condition <describe frequency/timing of inspection>. Damaged/deteriorated supplies will be replaced immediately.

<Position title of responsible personnel> is also responsible for ensuring that material and equipment source lists are accurate and up to date and that they include contact information and resources to be obtained from each source. The accuracy of the source list and the ability of each source to provide the listed resource will be verified <frequency> by <calling each source to verify their information/other>.

When the levee owner and local jurisdictions' resources are becoming depleted during a flood, requests for additional resources will be made through <Local/County/State Emergency Management Agency/Other>. Appendix O contains a list of floodfight material and equipment suppliers with contact information.

5.3 Floodfight Training

INSTRUCTIONS: *Staff and volunteers should also be trained to respond to emergencies, including pre-planned floodfight actions and notification procedures with a focus on known performance concerns. Provide the following information in this section:*

- *The person, by position title, responsible for planning and accomplishing floodfight training for staff.*
- *The frequency and content of floodfight training.*
- *The names of who will receive training.*
- *In some cases, floodfight training is covered in the discussion of emergency action plan exercises in a levee's emergency action plan. In these cases, this section can be deleted from the O&M manual.*

EXAMPLE LANGUAGE:

The <Levee Owner/Operator Organization Name> will perform floodfight training on an <frequency> basis. Floodfight training will be coordinated by <person by position title responsible for floodfight training> and will include a review of known performance concerns and training on floodfight actions to address them including detection, evaluation, classification, notification, and appropriate response actions during all incident classifications. <List those by position title that will be trained, including any volunteers> will be included in floodfight training.

6 During a Flood – Levee Operations

INSTRUCTIONS: *This section should describe the non-emergency operation and maintenance actions required immediately before and during a flood to ensure your levee system performs as intended. Incident response and emergency actions associated with performance concerns or overtopping events should be covered in a standalone emergency action plan. The* ***emergency action plan template*** *provides guidance in developing a standalone emergency action plan for a specific levee.*

An example of a table that can be developed to consolidate action triggers for all flood response actions is provided in Appendix P.

6.1 General

INSTRUCTIONS: *This section should name the entity that is responsible for operating the levee during floods. This will usually be the levee owner/operator's organization. It should also identify an individual within the operating organization, by position title, that is responsible for ensuring all actions are accomplished as described herein.*

This section can also provide overarching conditions to keep in mind as flood operations are implemented. Things to think about when deciding if providing overarching conditions would be helpful include:

- *How quickly will flood operations need to be performed based on the characteristics of the flood source? If the flood source is fast rising or lead time is otherwise limited, there may be significant urgency associated with flood operations.*
- *Are there any notifications or coordination actions that need to occur before gates are closed or closure structures are operated?*
- *Is there a need to balance closing gates associated with gravity drainage pipes in time to exclude exterior water with allowing gravity drainage to occur for as long as possible?*
- *Do closures block off important transportation corridors, especially evacuations routes? If so, full coordination with the corridor owner and precise timing of closure operation will be needed.*

The following are example overarching conditions:

- *The timing of response actions should be adjusted based on changing storm conditions or precipitation intensities to allow adequate time for the operation of project features.*
- *Gravity pipes are necessary for the removal of rainwater from the leveed area. Gate closures for these pipes should be timed to maximize removal of interior water while ensuring gates can be safely closed in time to prevent water from <flood source> from entering the leveed area. Gates that are closed during a flood should be opened as soon as possible after the water level on the <flood source> has receded below the level of water impounded within the leveed area.*
- *All preliminary inspections and notifications of impending closures at roads and railroads must be completed in advance to ensure there is time for the closure to be completely installed before water reaches the bottom sill.*
- *Road closures impact evacuation routes. Emergency management agencies for impacted areas must be notified in advance of closure structure operation.*

6.2 Non-Emergency Communications

INSTRUCTIONS: *This section describes the internal and external communication required to ensure the levee/owner operator, flood response partners, and other stakeholders are properly coordinating during floods. All communication triggers associated with floods can be summarized in Appendix Q – Flood Operation Checklist.*

6.2.1 Internal Communication

INSTRUCTIONS: *This section should provide the plan for internal communications during non-emergency conditions. This plan will keep levee staff aware of levee loading conditions, operation status, and other concerns. The plan should include a clear delineation of communication responsibilities. Often, this will be in the form of a call-down list or a notification flowchart.*

The plan should also include triggers for non-emergency internal communication. In many cases, the triggers for internal communication will be triggers discussed throughout this manual for pre-flood actions and feature operations.

Additional triggers that may be needed include:

- *Placing pump station operators on standby.*
- *Putting inspection teams on standby.*
- *Activating pump station operators and inspection teams.*
- *Keeping levee owner/operator leadership informed of conditions on the levee.*

6.2.2 External Communication

INSTRUCTIONS: *This section should describe the plan for keeping partners and the public aware of non-emergency conditions on the levee during a flood. This is an opportunity to make the public more aware of the benefits the levee is providing. The plan may include press releases and notifications to emergency management agencies and local municipalities. Direct communication with the public through social media or community websites can also be very effective.*

The plan description should include:

- *Triggers for non-emergency communication. For example, communication could be planned to occur when a flood is forecasted, prior to closing gravity drainage gates, prior to operating closures, and when the flood source crests. See also specific notification requirements associated with operating closure structures and gravity drainage pipe gates in Section 6.4.*
- *The person, by position title, responsible for making and executing decisions concerning non-emergency communication during floods.*
- *Partners that should be contacted directly.*
- *Methods/media to be used for notifications to the public.*
- *Any pre-scripted messages for standard non-emergency communications.*

The following table contains examples of non-emergency pre-scripted messages tied to action triggers. These messages should be tailored to fit a specific levee and community.

EXAMPLE TABLE:

Table 6-1. Pre-Scripted Non-Emergency Messages

Trigger	Pre-Scripted Non-Emergency Flood Communications
National Weather Service issues a flood warning	**Pre-Flood Notification** The National Weather Service has issued a flood warning for areas along the <flood source>. High water could impact the <Levee Name>; therefore, the <Levee Owner/Operator Organization Name> is continuing to monitor the levee and provide updates to emergency management personnel. Residents in <area> should remain vigilant and heed emergency warnings.
Closure structure notification trigger	**Closure Operation** Due to high water along the <flood source>, the <Levee Owner/Operator Organization Name> will be closing the <name of closure structure> located <describe location> in order to prevent water from entering <describe area where water would enter>. While closed, <describe impacts to roads, pedestrian pathways, etc.>. Travelers should consider the following alternate routes < describe alternate routes>.
All closure operations are complete	**Flood Notification** High water along the <flood source> is resulting in high water levels along the <Levee Name> near the area of <describe area>. In order to reduce the potential for flood waters to impact the community, all road and railway closures in the area of <describe area> have been installed. The <Levee Name> is currently performing well; however, conditions can change quickly during a flood. The <Levee Owner/Operator Organization Name> is continuing to monitor the levee and provide updates to emergency management personnel. Residents in <area> should remain vigilant and heed emergency warnings.

Note: Emergency communications and notifications should be described in the emergency action plan.

6.3 Pre-Flood Activities

INSTRUCTIONS: *This section should describe the pre-flood activities necessary to prepare the levee for a flood and defines the conditions that trigger them. These activities and the conditions that trigger them can be summarized in Appendix Q - Flood Operation Checklist. This introductory section should provide:*

- *The conditions that trigger the initiation of pre-flood activities.*
- *The person, by position title, responsible for overseeing pre-flood activities.*

6.3.1 Establish and Staff an Emergency Operations Center

INSTRUCTIONS: *This section should describe the location of the Emergency Operation Center (EOC) for flood response efforts. The EOC should provide a comfortable and safe place with sufficient room, supplies, and equipment to manage the flood response.*

Provide the following information:

- *Where the EOC will be established.*
- *What equipment (computers, phones, other) is available for the EOC and where it is stored.*
- *How the EOC will be staffed.*

6.3.2 Pre-Flood Inspection

INSTRUCTIONS: *The pre-flood inspection process description should include the following:*

- *The person, by position title, that will perform pre-flood inspections.*
- *How pre-flood inspections will be documented, including any equipment and/or checklists that will be used. The checklists should be added as attachments to the O&M manual.*
- *The person, by position title, to whom inspection results will be reported and that will determine necessary pre-flood repairs and ensure they are accomplished before the levee is loaded.*
- *Detailed instructions for the pre-flood inspection of each levee feature with a focus on making sure each feature is ready for a flood and if applicable, that it can be successfully operated.*

The following are examples of inspection instructions that may be helpful. The instructions for a specific levee should address levee system features, conditions, and known issues.

EXAMPLE LANGUAGE:

Access: Check for encroachments that could impede access and efficient operation and take the necessary actions to remove it. Ensure all gates are unlocked or keys are readily available. Ensure access roads are in good repair and can support flood response traffic.

Embankments: Inspect condition of embankments, including any recent repairs. Fill animal burrows, repair areas of erosion, repair or stabilize slides and sloughs. Ensure erosion protection is in good condition and repair as needed. Ensure all controlled overtopping locations are free of obstruction, have erosion protection in place, and are well marked.

Floodwalls: Inspect condition of floodwalls, including any recent repairs. Fill any animal burrows, erosion, or other holes/depressions near the floodwall. Check the floodwall joints for damage. Check the floodwall for movement and document pre-flood conditions.

Inspect closure structures and seals: Ensure stoplogs, other closure materials, and equipment necessary to install closures are available. More detailed guidance for closure structures is provided in Section 6.4.1.

Inspect condition of all gravity drainage pipes and gates: Gates will be submerged at a reading of <x.x> on the <gage name>, so it is imperative that the gates are inspected, and necessary servicing is performed in a timely manner. All gates should be inspected to ensure

that they are operable and can be securely closed. Objects and debris that might prevent the closure of the gate should be removed. More detailed guidance for gates is provided in Section 6.4.2.

Inspect and test pump station equipment: Make sure pump station operation and maintenance manuals are available at all pump stations. More detailed guidance for pump stations is provided in Section 6.4.3.

Inspect trash racks and remove debris: This must be done before a gage reading of <x.x> is reached at the <gage name>.

6.3.3 Pre-Flood Inventory of Materials and Equipment

INSTRUCTIONS: *This section should describe the process for inventorying materials and equipment immediately before a flood to verify adequate supplies are on-hand or can easily be resourced. Material and equipment lists and resource management procedures are provided in Section 5.2 of this manual.*

This section should provide:

- *The process for monitoring the use of resources and replenishing supplies during the flood.*
- *A list of floodfight resources available throughout the flood from emergency management agencies and/or others and how they can be obtained.*
- *A list of reliable suppliers for materials and equipment that will be procured immediately before or during floods, as shown in Appendix P.*

6.4 Operating Levee Features During a Flood

INSTRUCTIONS: *This section should provide detailed instructions for operating the levee during a flood. It should include all information needed to operate all closure structures, gates, and pump stations as flood waters rise. Before starting on this section, make a list of everything that needs to be done to effectively coordinate and accomplish timely operation of each feature of the levee. Use that list to make sure this section is complete.*

It is a best practice to develop triggers—such as certain water levels for riverine levees or storm predictions for coastal levees—to help ensure smooth operation of features during floods. Triggers should be developed for notifications and for operation. All operation activities and the conditions that trigger them can be summarized in Appendix Q - Flood Operation Checklist.

6.4.1 Closure Structures

INSTRUCTIONS: *Provide a table of all closure structures with location, closure type, size, invert elevation, and operation and notification trigger elevations. Notification triggers for closures are necessary because they are often located across railroads, pedestrian paths, or roadways. Sometimes the roadway or pathway that must be closed functions as an evacuation route. Both the notification trigger and the operation trigger for each closure should be coordinated with the owner of the corridor being impacted. If a roadway is a main evacuation route for the leveed*

area, local municipalities and emergency management agencies should also be consulted when developing notification and operation triggers.

The operation triggers for closures can be established by considering the amount of advance notice provided by flood forecasts, the time required to secure necessary staffing and materials, and the time required to complete the closure operation. If the levee contains multiple closures or closures with travel time from one to another, take this into consideration when determining operation trigger elevations.

Closures may be grouped if their type and operation procedures are the same. For each closure, provide the following information:

- *The process for ensuring the closure is installed in a timely manner and all necessary coordination is accomplished (coordination will include internal notifications to initiate operations and external notifications to railroads, departments of transportation, emergency management agencies and/or others).*
- *The person, by position title, responsible for making required notifications.*
- *The person, by position title, responsible for ensuring the closure is operated in accordance with this O&M manual.*
- *The equipment and number of people required to safely operate the closure; the source for equipment and closure staff (levee owner/operator staff, volunteers, other); when people and equipment should be put on stand-by (typically when the notification trigger is met).*
- *The materials required to operate the closure structure.*
  - *Structural assembled closures: Describe where removable structural components are stored, how they are organized, and how they are deployed to the closure site. Provide a reference to closure assembly instructions.*
  - *Movable closures: These closures typically consist of gates stored at the closure location. If additional materials are needed, list those materials here. Provide a reference to gate closure instructions.*
  - *Earthen assembled closures: Describe where stored materials are located and how they are deployed to the site. For materials that are procured immediately before the flood, provide a reference to supplier information (typically provided in Section 5.2), and provide the schedule and process for having materials delivered to the closure structure site.*
- *The amount of time required to accomplish the closure, including time to mobilize equipment, resources, and people to the closure site.*
- *A provision for manual backup for the activation of automatic systems.*
- *The roadway, railroad, path, or other opening that the closure is located on and required notifications associated with closing the corridor.*

- *If operation of the closure will block an evacuation corridor, describe the required coordination with local emergency management agencies or other entities. Notifications should occur well before the closure is operated.*

EXAMPLE TABLES:

Table 6-2. Closure Structures – Operation

Closure Name	Type	Location	Size (ft) (Width x Height)	Time to Install (hrs)	Sill El. (ft)	Notification Trigger (ft)	Operation Trigger (ft)
North Burlington closure	Stoplog	station x+x	50 x 14	18	103	98	100
Main Street swing gate	Swing	station x+x	60 x 13	4	102	100	101
River Park flood gate	Swing	station x+x	40 x 15	12	99	97	98
County Road W closure	Sandbag	station x+x	40 x 1.5 (750 bags)	36	108	108	110

Table 6-3. Closure Structure – Notification Contact List

Closure Name	Coordinating Organization	Primary Contact	Phone Number
North Burlington closure	North Burlington Railroad		
Main Street swing gate	City Engineers		
River Park flood gate	Park and Recreations Departments		
County Road W closure	Departments of Transportation		

6.4.2 Pipe Gates

INSTRUCTIONS: *Provide a table of all gates with location, gate type, size, invert elevation, and operation and notification triggers. For each gate, provide guidance for all activities required to operate the gate in response to a flood.*

Notification triggers for gates are necessary because they are often associated with interior drainage systems. Closing gates prevents water from exiting the leveed area via normal means and may require operation of a pump station or other interior water management method be put in place. Gates can also be associated with pressurized sewer systems or other utilities, requiring close coordination with local utility companies.

The operation triggers for gates can be established by considering the amount of advance notice provided by flood forecasts, the time required to secure necessary staffing and to close

the gate, and how closing the gate impacts interior drainage. In some cases, the operation trigger may consider both the elevation of the flood source and the elevation of any interior drainage water. If the levee contains multiple gates or gates with travel time from one to another, take this into consideration when determining operation trigger elevations.

Gates may be grouped if their type and operation procedures are the same. For each gate, provide the following information:

- *The coordination process for ensuring the gate is closed in a timely manner and person, by position title, responsible for making sure all necessary coordination is accomplished (coordination will include internal notifications to initiate operations and external notifications as needed).*
- *The person, by position title, responsible for implementing the coordination processes.*
- *The person, by position title, responsible for ensuring the gate is operated in accordance with this O&M manual.*
- *Any equipment required to close the gate.*
- *The amount of time required to close the gate, including time to mobilize equipment and people.*
- *A provision for manual backup for the activation of automatic systems.*
- *How closing the gate impacts interior drainage and what features or methods are in place to manage interior water while the gate is closed.*

EXAMPLE TABLES:

Table 6-4. Gravity Drainage Pipe Gates – Operation

Gate Name	Location	Gate Type	Gate Automated	Size (in)	Gate Invert/Sill Elevation (ft)	Notification Trigger (ft)	Closure Trigger (ft)
Pump Station #1 Gate	station x+xx	sluice	no	30	96	94	95
Big Ditch Gate	station x+xx	sluice	no	60	97	94	96
Little Ditch Gate	station x+xx	flap	na	24	97	na	97.5*
Pump Station #2 Gate	station x+xx	flap	na	30	97	na	97.5*

* Verify flap gate closure.

Table 6-5. Gravity Drainage Pipe – Notification Contact List

Closure Name	Coordinating Organization	Primary Contact	Phone Number
Pump Station #1 Gate	City Engineer		
Big Ditch Gate	Anderson Farm		

6.4.2.1 Flap Gate and Duckbill Gates

INSTRUCTIONS:

Pre-Flood Preparations. *Describe the gate inspection process. Describe the process for reporting and addressing any needed repairs or issues with proper gate operation.*

Close Gate. *The gates operate passively so operation is not needed; however, they should be observed throughout the flood to ensure they are performing as expected. Describe how flap gates and duckbill gates will be inspected during the flood.*

6.4.2.2 Sluice Gate Closures

INSTRUCTIONS:

Pre-Flood Preparations. *Describe the gate inspection process. Describe the process for reporting and addressing any needed repairs or issues with proper gate operation. Discuss special considerations for closing gates on gravity pipes that are needed to remove surface water from the leveed area, including any notifications that are required before the gate can be closed.*

Close Gate. *State who is responsible for closing sluice gates, the time needed to accomplish all closures including travel time, and any tools or equipment required.*

Also discuss any pressure sewers with emergency closures that will need to be monitored and operated as needed. These features often require close coordination with a local utility.

6.4.3 Pump Stations

INSTRUCTIONS: *Provide a table that summarizes the characteristics of the pump station(s) associated with the levee. In most cases, each pump station will have its own O&M manual. It is recommended that this section summarize operation triggers for each pump station and then reference each individual pump station O&M manual and where it is stored. It is a best practice to have a back-up of each O&M manual stored in a separate location in case the on-site manual is damaged or lost.*

Pre-Flood Preparations. *Describe the pre-flood inspection and pump testing process. Describe the processes used to:*

- *Put operators on standby.*

- *Make sure adequate fuel/power supply is available (including fuel for backup power).*
- *Inspect and test all pumps in preparation for operation.*
- *Make any notifications that are required before pump stations begin operation.*

During a Flood. *Summarize pump station operation procedures during a flood, including triggers for turning each pump on and off and provisions for manual backup of automatic systems. Pump station operation triggers are usually tied to water elevations in the pump station ponding areas. Provide a reference to pump station specific O&M manuals for detailed operation procedures.*

EXAMPLE TABLE:

Table 6-6. Pump Stations

Name	Levee Station	Pump	Flow (GPM)	Motor (HP)	Trigger – On Ponding Area El. (ft)	Trigger – Off Ponding Area El. (ft)
Pump Sta. #1	134+22	Pump No. 1	33,350	300	100	98
		Pump No. 2	33,350	300	102	100
		Pump No. 3	33,350	100	105	101
Pump Sta. #2	12+43	Pump No. 1	6,700	75	102	98

7 After a Flood – Recovery

INSTRUCTIONS: *This section describes the activities that occur immediately after a flood to return the levee to pre-flood conditions. Information in this introductory section should include:*

- *The person, by position title, responsible for making sure all post-flood activities are accomplished in accordance with this manual.*
- *The person, by position title, that will review before, during, and after flood inspection findings and determine appropriate repairs, rehabilitations, and other risk management actions in the post flood inspection.*

7.1 Post-Flood Inspections

INSTRUCTIONS: *This section should describe the post-flood inspection to document the extent of damage to the levee. The post-flood inspection process description should include the following:*

- *The person, by position title, that will perform post-flood inspections.*

- *The process by which post-flood inspections will be documented, including any equipment and/or checklists that will be used. Checklists should be added as attachments to the O&M manual.*

Typically, Section 2.8 of this O&M manual will describe how post-flood inspection documentation will be organized and stored long term. Reference the documentation section here.

Typically, Section 2.5 of this O&M manual will describe how damages identified during the post-flood inspection are incorporated into the levee's prioritization process for actions to reduce and manage risk. Reference the prioritization section here.

7.2 Levee Performance Documentation

INSTRUCTIONS: *Describe the processes to consolidate, organize, and evaluate performance and floodfight data collected during the flood. (How the data is stored is typically covered in Section 2.8 of this O&M manual). Describe the products that will be developed, such as:*

- *Maps depicting areas of good performance and performance concerns.*
- *A record of performance issues with floodfight actions and their effectiveness.*
- *Flood hydrographs to tie performance observations to flood source conditions.*

7.3 Removing Floodfighting Materials

INSTRUCTIONS: *Describe the process for removing and demobilizing temporary floodfight materials including:*

- *A plan for returning reusable materials and equipment to operational condition.*
- *A plan for disposing of materials that can no longer be used.*

7.4 Demobilizing Equipment

INSTRUCTIONS: *Describe the process for removing and demobilizing floodfight materials and equipment including:*

- *Demobilization priorities.*
- *Release procedures.*
- *Travel information.*

Appendix A – Levee Location and Access Map

INSTRUCTIONS: *Provide a map or maps that show the location of the levee, all levee features, and levee access points. It is helpful to include the location of locked gates or other obstacles.*

Appendix B – Levee As-Built Drawings

INSTRUCTIONS: *Provide the levee as-built drawings. A link to this information can be provided if preferred.*

Appendix C – Levee Staff and O&M Service Providers

INSTRUCTIONS: *An example table with example entries is provided below. All entries are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table C-1. Levee Staff Contact Information

Name	Position Title	Primary Responsibility or Skill	Phone Number
Name	Title	Description	xxx-xxx-xxxx
Name	Title	Description	xxx-xxx-xxxx
Name	Title	Description	xxx-xxx-xxxx
Name	Title	Description	xxx-xxx-xxxx
Name	Title	Description	xxx-xxx-xxxx
Name	Title	Description	xxx-xxx-xxxx
Name	Title	Description	xxx-xxx-xxxx
Name	Title	Description	xxx-xxx-xxxx
Name	Title	Description	xxx-xxx-xxxx

Table C-2. O&M Service Providers

Levee Features	Company Name	Primary Contact	Phone Number
Culvert inspection	Name	Contact Name	xxx-xxx-xxxx
	Name	Contact Name	xxx-xxx-xxxx
Relief well pump test	Name	Contact Name	xxx-xxx-xxxx
	Name	Contact Name	xxx-xxx-xxxx
	Name	Contact Name	xxx-xxx-xxxx
Megger testing of pumps	Name	Contact Name	xxx-xxx-xxxx
Tree maintenance and removal	Name	Contact Name	xxx-xxx-xxxx
	Name	Contact Name	xxx-xxx-xxxx
Grass mowing	Name	Contact Name	xxx-xxx-xxxx

Appendix D – Embankment

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table D-1. Embankment O&M Schedule

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspection			x						x			
Repair slope sloughs and slides				x						x		
Repair erosion and other surface damage				x						x		
Remove debris and trash	x			x			x			x		
Fill animal burrows		x		x		x		x		x		x
Monitoring surveys				YE 0,5								
Read inclinometers		x		x		x		x		x		x
Vegetation Management												
Mow embankment				x	x	x	x	x	x			
Spray for weeds and for unwanted vegetation along fence lines, in roadways, and in erosion protection				x		x		x				
Limb trees as needed										x		
Remove sick or dead trees										x		
Re-seed damaged vegetation areas as needed			x	x	x	x	x	x				
Erosion Protection												
Replace missing or degraded riprap				x						x		
Repair cracks in riprap grout					x						x	
Repair cracks in slope pavement					x						x	

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Repair/replace damaged areas of slope pavement					x						x	
Access Roads												
Regrade gravel surfaces						x						
Fill potholes and ruts	x	x	x	x			x				x	x
Add gravel						YE in 3,6,9						
Remove debris and other obstructions	x			x			x			x		
Transitions												
Inspect for erosion and settlement			x						x			
Maintenance: see embankment schedule above												

Appendix E – Floodwall

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table E-1. Floodwall O&M Schedule

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspection				x						x		
Concrete surface and crack repairs					x						x	
Monolith joint repairs						x						x
Fill animal burrows		x		x		x		x		x		x
Repair erosion adjacent to floodwall					x						x	
Remove debris and trash	x			x			x			x		
Top of wall surveys				YE 0,5								
Vegetation Management												
Mow areas adjacent to floodwall				x	x	x	x	x	x			
Spray for weeds				x		x		x				
Erosion Protection												
Replace missing or degraded riprap				x						x		
Repair cracks in riprap grout					x						x	
Access Roads												
Regrade gravel surfaces						x						
Fill potholes and ruts	x	x	x	x			x				x	x
Add gravel						YE in 3,6,9						
Remove debris and other obstructions	x			x			x			x		
Transitions												

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspect for settlement			x						x			
Maintenance: see floodwall schedule above												

Appendix F – Closure Structures

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table F-1. Closure Structures O&M Schedule

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspection				x						x		
Concrete surface and crack repairs					x						x	
Monolith joint repairs						x						x
Repair/replace sills					x						x	
Fill animal burrows		x		x		x		x		x		x
Repair erosion adjacent to closures					x						x	
Clean and paint gates and other metal parts			YE 5									
Test operation of North Burlington stoplog closure									YE 2			
Test operation of Main Street swing gate									x			
Test operation of River Park swing gate									x			
Test operation of County Road W closure									YE in 3,6, 9			
Survey settlement markers on North Burling closure		YE 0, 5										
Lubricate mechanical parts			x						x			
Transitions												
Inspect for settlement												
Maintenance: see closure structures schedule above												

Appendix G – Relief Wells

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table G-1. Relief Wells (Seepage Control Measures) O&M Schedule

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspection			x						x			
Replace damaged and missing parts			x						x			
Remove sediment and debris from around relief wells				x						x		
Repair erosion and other surface damage				x						x		
Fill animal burrows		x		x		x		x		x		x
Interior relief well inspections			YE 1,6									
Relief well pump tests							YE 1,6					
Interior inspection of relief well drainage system pipes			YE 4,9									

Appendix H – Drains

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table H-1. Drains (Seepage Control Measures) O&M Schedule

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspection			x						x			
Replace damaged and missing parts			x						x			
Remove sediment and debris toe drain outlet				x						x		
Repair erosion and other surface damage				x						x		
Fill animal burrows		x		x		x		x		x		x
Interior inspection of floodwall toe drain			YE 4,9									

Appendix I – Channels and Floodways

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table I-1. Channels and Floodways O&M Schedule

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspection			x						x			
Repair slope sloughs and slides				x						x		
Repair erosion and other surface damage				x						x		
Remove sediment and debris		x						x				
Erosion Protection												
Replace missing or degraded riprap				x						x		
Repair cracks in riprap grout					x						x	

Appendix J – Gravity Drainage Pipes, Gates, and Headwalls/Gatewells

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table J-1. Gravity Drainage Pipes, Gates, and Headwalls/Gatewells O&M Schedule

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspection				x						x		
Gravity Drainage Pipes												
Interior inspection gravity drainage pipes			YE 3,8									
Pipe/culvert joint cleaning and repair						x						x
Coat, seal, repair small areas of corrosion												
Sediment and debris removal			x						x			
Headwalls												
Repair erosion and animal burrows at headwalls and gatewells					x						x	
Concrete surface and crack repairs					x						x	
Concrete joint repair					x						x	
Gates												
Test operation of all gates				x						x		
Clean and paint gates and other metal parts			YE 5									
Repair/replace gate sills					x						x	
Lubricate mechanical parts			x						x			

Appendix K – Ditches and Ponding Areas

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table K-1. Ditches and Ponding Areas O&M Schedule

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspection		x						x				
Repair slope sloughs and slides				x						x		
Repair erosion and other surface damage				x						x		
Remove sediment and debris			x						x			
Remove/manage vegetation			x						x			

Appendix L – Pump Station

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table L-1. Pump Station O&M Schedule

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspection				x						x		
Pump Station Building and Components												
Cleaning and painting metal surfaces					x							
Roof repairs											x	
Sealing wall joints and cracks					x						x	
Cleaning storage and work areas		x		x		x		x		x		x
Pump Motors and Power Systems												
Adding/replacing oil				x						x		
Lubricating parts				x						x		
Adjusting and replacing belts and seals				x						x		
Aligning gears and drives				x						x		
Inlet and Outlet Works												
Interior inspection of discharge pipes			YE 3,8									
Test operation of all gates and valves				x						x		
Clean and paint gates and other metal parts					x						x	
Repair/replace gate sills					x						x	
Lubricate mechanical parts					x						x	
Remove silt and debris, including from trash racks	x	x	x	x	x	x	x	x	x	x	x	x
Clean and paint trash racks					x						x	

Appendix M – Instrumentation

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table M-1. Instrumentation O&M Schedule

Activity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Inspection				x						x		
Replace missing or damaged parts					x						x	
Recalibrate	x											

Appendix N – Record of Prioritized O&M Activities

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table N-1. Record of Prioritized O&M Activities

Record of Prioritized Operation and Maintenance Activities **Date:**						
Purpose: This document details prioritized actions for operation, maintenance, repair, replacement, and rehabilitation for the levee system. It is based on best available levee information from inspections and risk assessments.						
Levee System Name:				**NLD System Number:**		
Levee Segment Name(s):				**NLD Segment Number(s):**		
Priority	**Tracking No.**	**Date**	**Action**	**Responsible Party**	**Status**	**Notes**

Appendix O – On-Hand Floodfight Materials and Equipment

INSTRUCTIONS: *An example table with example entries is provided below. All frequencies and activities are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table O-1. On-Hand Floodfight Materials and Equipment

Description	Quantity	Location
Pickup truck		
Tandem axle trailer		
Backhoe		
Sandbags		
Sand		
Plastic sheeting (6 mil)		
Medium-weight non-woven geotextile		
Cell phone		
Flashlight and batteries		
Spotlight		
Shovels		
Bolt cutters		
Chainsaw		
Jumper cables		
Toolbox (hammer, diagonal plyers, vice grips, screwdrivers, wrenches, etc.)		
Fire extinguisher		
Lubricant		

Appendix P – Floodfight Materials and Equipment Suppliers

INSTRUCTIONS: *An example table with example entries is provided below. All entries are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table P-1. Floodfight Materials and Equipment Suppliers

Material or Equipment	Company Name	Primary Contact
Sandbags	Name	Name
Sand and gravel	Name	Name
Sand and gravel	Name	Name
Polyethylene sheeting	Name	Name
Equipment rental	Name	Name
Generators	Name	Name
Emergency lighting	Name	Name
Deisel fuel	Name	Name

Appendix Q – Flood Operation Checklist

INSTRUCTIONS: *An example table with example entries is provided below. All entries are examples to help levee owner/operators determine appropriate levee specific entries and should not be considered recommendations or requirements.*

EXAMPLE TABLE:

Table Q-1. Flood Operation Checklist

<Levee Name> FLOOD OPERATION CHECKLIST				
Triggering Condition	**Action**	**O&M Manual Section**	**Responsible Person**	**Contact Information**
River Gage El. = 90	Internal pre-flood notifications/coordination (non-emergency)	6.2.1		
River Gage El. = 91	External pre-flood notifications/coordination (non-emergency)	6.2.2		
River Gage El. = 91	Establish and staff the EOC	6.3.1		
River Gage El. = 91	Perform pre-flood inspection of all levee features, make repairs as needed	6.3.2		
River Gage El. = 91	Perform pre-flood inventory of materials and equipment	6.3.3		
River Gage El. = 92	Notify city engineer that pump station #1 sluice gate will be closed	6.4.2		
River Gage El. = 92	Notify Anderson Farm that Big Ditch sluice gate will be closed	6.4.2		
River Gage El. = 93	Close pump station #1 sluice gate	6.4.2		
River Gage El. = 93	Begin monitoring pump station #1 sump elevation	6.4.3		
Ponding Area #1 El. = 97	Begin operating pump station #1 per pump station O&M manual	6.4.3		
River Gage El. = 94	Close Big Ditch sluice gate	6.4.2		
River Gage El. = 95	Notify Parks and Rec that River Park swing gate will be closed	6.4.1		
River Gage El. = 97	Close River Park swing gate	6.4.1		

Appendix R – Environmental Permits and Agreements

INSTRUCTIONS: *Provide any environmental permits and agreements. A link to this information can be provided if preferred.*